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An Intelligent Vibration Plate Made of Ultra-thin Material

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Abstract

Intelligent vibration plate design technology is a key factor in China's realization of independent supply of production parts. In recent years, with the continuous improvement of China's industrial production automation level, this technology has been widely used in electricity, hardware, plastics, medicine, food, toys, stationery, daily necessities and other industries. The improved design of the vibration plate can improve production quality, enhance manufacturing accuracy, and thus reduce production costs. Under the fierce market competition and the trend of mechanical globalization, users have an increasing demand for manufacturing quality to improve efficiency, which puts forward more stringent standards for the design of vibration plates.

Keywords

Vibration plate; ultra-thin material; feeding; status quo analysis

Introduction

The vibration plate is a new type of vibration machine developed by China, a vibration material conveying tool, which is also an important basis for China to overcome the problem of automatic conveying of parts and materials. In order to make the oscillator swing in the vertical direction, the basic pressure is used. The oscillator is guided by the spring. The lower roller swings around the vertical axis, and with this swing, a part of the feed port rises along the spiral trajectory and is finally introduced into the lower roller port.

1. Current status of intelligent vibration plate

1.1 Development of intelligent vibration plate

As one of the most critical technologies in modern manufacturing in the early 20th century, the automation of industrial production is mainly about the consistency of manufacturing quality. In the evolution of modern manufacturing automation, almost every imported equipment can be digested and absorbed. Subsequently, people have carried out secondary development and application of common mechanical vibration conveyors, including electromagnetic vibration conveyors and vibration plates. They are widely used in the automatic production and assembly of optics and electronics, as well as the automatic handling and loading and unloading of pharmaceutical and food production equipment. In the software management part of the controller, by changing the vibration time and range of the vibration plate, it is possible to arrange the products in an orderly manner on the transport rollers. In recent years, due to the increasing labor costs in China, it has become a new trend to replace manual material selection and feeding with machinery. However, because most of the piezoelectric vibration plate controllers in China are currently imported from abroad, they face the situation of high production costs and troublesome maintenance. And the sensors in China

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are still in the research and development stage. The resonance point control is complex, the functions are not fixed, and the cost performance is relatively low. Therefore, the development and application of vibration plate sensors has great practical significance [1].

1.2 Structural design of vibration plate

The environmental adaptability and durability of materials used for parts that have a great adverse impact on production safety and reliability should be fully considered, taking into account various factors that affect the environment, such as high temperature, humidity, vibration, and air pollution. Reasonable protection should be given to all aspects of the building to prevent casualties and strength reduction caused by temperature, corrosion, damage, and other reasons. If a high temperature is generated inside the connection structure, the stress that may be caused by such high temperature deformation and the damage range to the part structure must be considered. Stress concentration should be minimized, additional bending moment should be reduced or avoided, the transmission form of reverse force should be avoided, and the stress of complex loads should be controlled. In order to improve the fatigue resistance of the structure, appropriate material selection is required. For example, Shenzhen Gaoshida Technology manufactures non-standard customized aluminum precision vibration plates for various precision parts and materials. The actual picture is shown in Figure 1 [2].

Figure 1. Aluminum precision vibration plate.

1.3 Use of vibrating plate feeder

Although the vibration plate is stable in operation, safe and reliable in use, easy to operate and simple to maintain, it has been verified through actual practice that if a problem occurs, it will be damaged in the short term without stopping for detection or eliminating it. Therefore, both the operation management personnel and the maintenance inspection personnel must understand the characteristics of the vibration plate and perform correct maintenance in accordance with the operating procedures to ensure the continuous and normal operation of the vibration feed pump. (1) Precautions during operation: Check whether there are factors that interfere with the vibration around the vibration plate. Once found, they should be eliminated immediately. Check whether the vibration plate body is in normal condition: whether all nuts are tightened (spring tightening nuts are particularly important); check whether there are breaks in welding wires, etc.; whether the vibration plate is at the same level. Check the integrity, sensitivity and reliability of various control devices. Check whether the position of the discharge port and the position in the material plate are the same, etc. (2) Precautions for starting: whether the start is normal, and the voltage adjustment knob should be adjusted to gear 0 during startup. After starting, whether there are abnormal noises and vibrations, and whether the feeding state is balanced, coherent, loose, and accurate. (3) Precautions during operation: observe whether the vibration phenomenon is normal, observe whether the feeding is stable, check whether the bolts are loose, whether there is any abnormal noise, check whether the electromagnet exceeds the allowable temperature rise, detect the sealing effect of the sealing device, check whether there is any overflow or blockage, and whether it affects the vibration effect. (4) The use of the electromagnetic oscillation feeder: after connecting the conversion switch of the electromagnetic vibration plate, make the indicator light on, connect the electromagnetic excitation force machine to the power grid, and adjust the voltage regulator controller after starting the electromagnetic vibration plate machine, so that the required value of the feeding amount can be adjusted and the voltage stabilization action can be completed. The high-precision electromagnetic drive base is most suitable for realizing the direct vibration track for automatic feeding of micro-small parts and high-speed precision parts. The front and rear of the machine body are equipped with leaf spring anti-vibration devices that absorb reaction forces, which can obtain the best vibration characteristics that meet the shape of the parts, such as the electromagnetic vibration plate base in Figure 2 below [3].

Figure 2. Electromagnetic vibration plate base.

2. Research progress of smart materials in structural vibration control

2.1 Design method of intelligent structure vibration controller

Vibration control is one of the important applications of intelligent material structures. The research in this field started early and has achieved fruitful results. However, as an interdisciplinary high-tech, the practical application of his ideas and research has suffered great investigation and failure. His exploration and achievements can be summarized as follows: the design and research of intelligent structural vibration control system devices rely on design data and technical simulation to a large extent, especially the characteristics of vibration feedback information and drive data. At the same time, the design and control methods of structural vibration sensors are also inseparable from the progress of science and technology. In the late 1980s, the main application of intelligent design technology in the field of structural vibration control systems has focused on creating mechanical modeling of structural intelligent systems and realizing the control characteristics of sensors, actuators, material processing equipment and electronic process systems. This mainly involves the optimal control method of structural model parameters, which depends on relatively stable excitation conditions and widely used structural intelligent control technology. The former is relatively mature in research and application, while the latter is more advanced. However, the practical application of intelligent structural vibration control systems still requires more in-depth research and development. The following briefly explains the practical application of optimal control theory and intelligent control theory in structural vibration control systems. The optimal control theory is based on the state space theory in modern control theory. The optimal control calculation is also the most common control system design method in the structural vibration control system. Its main purpose is to provide the controller with an accurate structural data model, as well as clear excitation and measurement information. Although the optimal control theory is limited in practical application, it is still the basic technology of modern vibration control systems. Due to the improvement of modern high-tech, the optimal control theory has also been greatly improved and improved. The low-power design method is an optimization design method used to adjust the minimum power that meets the design requirements of a given attenuation ratio of the power system. The main steps include reducing the system modal truncation order, optimizing the control design, closed-loop verification, locally changing the modal damping ratio and iterative calculation. The method uses full state feedback to optimize the alignment of sensors and actuators, and uses a state observer to form a closed-loop system. The design method of the pole allocation system based on the covariance principle of the original invention can ensure the state stability of the entire system, that is, it can transfer the initial state of the system to the predetermined state, and cannot determine the large transient characteristics of the state variables during the operation of the system. However, in actual situations, due to the large transient of the state variables, the linear assumption of the system model is completely or partially destroyed by the reed. The objective function is the sum of the modal coefficients between the control state covariance matrix and the control state input covariance matrix. However, the design of covariance control often requires a large number of iterative operations, which is not conducive to real-time control. For example, by designing distributed network structure control technology, the controller design types of the control system are more and more complex. By designing multiple controller subsystems, the difficulty of controller design can be reduced. This method is particularly suitable for the study of local vibration of complex structures. The distributed method assumes that the control of each subsystem is decoupled, and the physical connection between each subsystem can be described by related differential equations. By constructing a related model and introducing the objective function of optimal control of the corresponding subsystem, the dynamic process of the corresponding subsystem is designed [4, 5].

2.2 Smart material structure vibration control model

Another major task of vibration control of intelligent material systems is to study the vibration limitation problem of large-scale complex systems. Thin composite structures and flexible optical designs have also been widely adopted, and the motion characteristics of the structure are very complex. The mathematical model can divide it into several sub-units according to the natural conditions inside the vibration plate. However, the mathematical model of the vibration controller in the intelligent structure increases the coupling performance of multiphase materials and the complexity of the controller design. However, the vibration controller model in large or complex structures (such as vibration plates) has not been implemented. Therefore, most studies start from the most basic method light. For the dynamic simulation of the composite structure of intelligent piezoelectric sensors, it is usually assumed that the sensor plate is firmly connected to the structure with the actuator, and the mechanical pressure provided by the actuator is proportional to the speed of change of the electric excitation field. The load generated by the piezoelectric sensor is proportional to the speed of mechanical change received, so the piezoelectric secondary response can be omitted. This optimization is also valuable under the premise of slight changes in the structure. Therefore, nonlinear control systems have always been the key research area of intelligent vibration control systems and a very critical theoretical issue. Because the stiffness of the piezoelectric separation structure basically does not change. As a sensor driver material for lightweight composite systems, piezoelectrics are also important for design performance. So generally speaking, the emergence of piezoelectric elements slightly reduces the natural vibration frequency of mechanical components. Considering the interaction between the actuator and the sensor and the motion characteristics of the mechanical structure, people usually define the dynamic equation of the composite structure according to the energy theory. The mechanical change characteristics of the structure are associated with the internal and external feedback information of the structure, so as to obtain the input-output process of the control system or the input-output matrix of the control system. In the future, the main research trend of the dynamic model of intelligent composite material structure will be to select the most accurate mechanical deformation model of the composite material by analyzing the precise coupling characteristics between mechanical, electro-optical, thermal decomposition and other sensor signals. Then, in order to solve specific technical problems, a dynamic model of a large or complex structural system with multiple local structures is constructed. However, this additional design work is also difficult. First, the initial design may generate many nonlinear variables in the model. At the same time, the control method based on the nonlinear variable system has not been completed in the nonlinear factor controller, so the design of the nonlinear factor controller also depends on the further development and improvement of control technology. Secondly, the controller design work and real-time control for larger-scale MIMO systems also require further progress in computer hardware technology and digital signal processing technology [6].

3. Summary

Experimental research on vibration control of smart material structures is a necessary step from theory to practice. Because this is an emerging topic with a relatively short development history, the level of empirical research results is still very weak. The current empirical research content mainly includes: establishing intelligent composite models, designing various electronic instruments and devices, and electronic computer software and hardware engineering. The current experimental research involves signal amplification, filters, power amplification, control power supply, AD/DA, computers, etc. Therefore, the practical issue of the vibration function of smart composite materials is a key research topic in this regard.

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