四、本科生出版专著、发表论文情况

1. The design of a new type of spindle vibration test device
2. The research and design of virtual spindle vibration test system
3. 各校化校园工艺品产品开发
4. 立体织物整体穿刺机穿刺机构运动学分析

Applied Mechanics and Materials Vols. 556-562 (2014) pp 1460-1463

doi:10.4028/www.scientific.net/AMM.556-562.1460

The design of a new type of spindle vibration test device

Dong Fang[1,2], Yang Jiancheng[1,2] ,Gao Tianzhu[1,2],Xie Yu[1,2],Guo Lei[1,2],
Zhang Haiyang[1,2],Hu Shiming[1,2],Zhou Guoqing[1,2]

[1]School of Mechanical and Electronic Engineering, Tianjin Polytechnic University

[2]Tianjin Key laboratory of Advanced Mechatronics Equipment Technology, Tianjin Polytechnic University, Tianjin, China

472814117@qq.com

Keywords: spindle; vibration test; Labview; control

Abstract. In this paper, a set of spindle vibration test equipment has been designed by using modern design method, on the basis of in-depth study of spindle vibration source .The device includes three parts: machinery, detection and control .In the mechanical part, using sensor fixed machine mobile systems, the design of the spindle drive part and test board was carried on respectively .In the detection part ,the virtual instrument Labview graphical programming language was adopted to form a spindle vibration test and analysis system, realizing the acquisition, processing and analysis of the vibration signal .In the control part, Yan Hua movement control cards are adopted to realize control of motor speed, through Labview programming.

Introduction

Spindle is the main component in twisting winding and the symbolic element of the spinning machinery parts .The service behavior directly affects the yield and quality of spinning, playing an important role on the development of textile industry .The two key problems of spindle at high speed are the vibration and noise[1]. In the process of using spindle, minimal processing error or deformation can cause strong vibration. Therefore, developing a spindle vibration testing devices of great significance to improve the spindle speed and reduce noise. Aiming at above problem, this design developed a new type of spindle vibration testing device, to test the vibration of the spindle at different rotational speed .The device consists of three parts: the sensor fixed machine mobile system, data acquisition test system and motor speed control system[2].

The design of sensor fixed machine mobile system

The mechanical structure of the test device is shown in Fig.1.

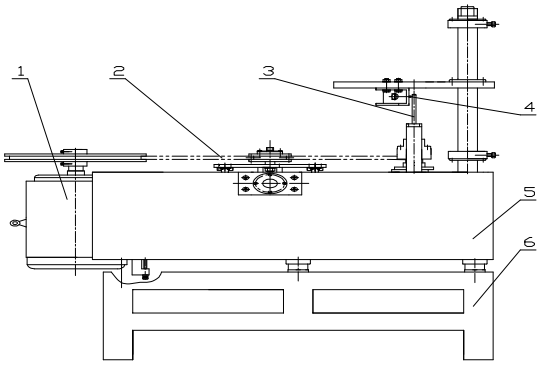


Fig.1 The mechanical structure of test device

1-motor 2-spindle tape 3-spindle 4- sensor 5-bottom case 6-base frame

Because the spindle drive has particularity, so the spindle tape will be used for the belt .Because of the motor speed of 2870 r/min, in order to achieve high speed that spindle operation need, so more than 10 ratio is needed to meet the requirements .The spindle wharves is 24-27 mm in diameter .So the diameter of hockey among 250-280 mm can guarantee the transmission ratio is

more than 10. The tested spindle is a splint fixed in the nut.ZDF24 non-contact sensors are adopted in the test device. They are installed 2 mm (maximum 5 mm) according to the measured body surface, relative to the ground without vibration displacement, screw fixation .The test platform is made of the granite body structure. It not only can reduce the influence of the vibration of the spindle of the test, but also prevent miscellaneous light interference .To fix other structures, metal sleeves need to be inlaided in granite body .6 is frame ,which is used to support the mechanical structure.

Design of the transmission mechanism

Since the transmission ratio required more than 10 different spindle whorls of different diameters and therefore the transmission ratio mechanism is 10.3-11.7[3].Transmission route for motor - spindle reel - Tapes – spindle .Transmission structure is shown in Fig.2.

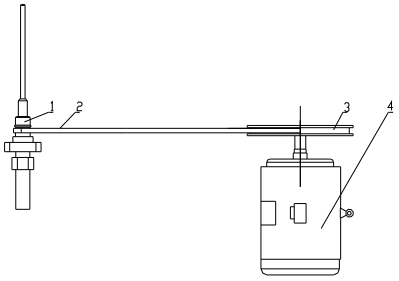


Fig.2 Transmission diagram
1 spindle 2 spindles with 3 spindles pulley
4. Motor

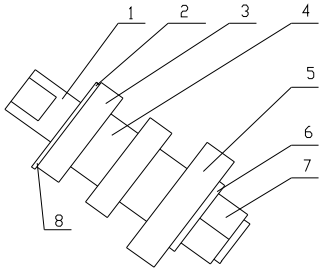


Fig.3 Tensioner internal structure
1 tensioning shaft 2 Hole Collar 3 Rolling
4 sleeve 5.Floor 6.Gasket 7.Nut 8. Shaft Collar

Design of tensioning mechanism

(1)The design of the tension wheel :The shape of tensioner is same as reel spindles .In order to reduce the friction the tension wheel must be able to rotate with the spindle .The rolling bearing structure needs to increase into the tension wheel to meet the operation and the tension wheel must be fixed to the holder .So the internal design of the tension wheel is shown in Fig.3 below.

(2)The design of tensioners mobile device :in order to make the clamp wheel to realize the relative movement, clamping wheel should be first laid on bracket, ensure the stability of tension wheel in the vertical direction .To ensure the relative movement of tension wheel，structure of the following can be designed：Equip different-direction screw nut mechanism on either side of the screw .Two stents are respectively fixed in two different spin to the screw nut .In the movement screw guide rail and slide block device reduce the friction resistance and make the clamping device more flexible .So the tension wheel mobile device structure is as shown in Fig.4.

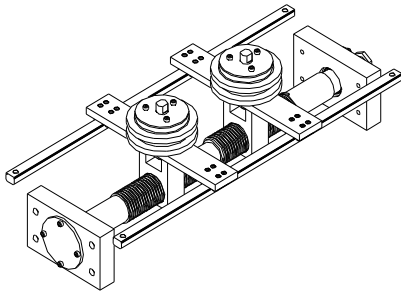


Fig.4 Axonometric drawing of tension wheel mobile devices

（3）The selection of screw thread length: according to the industry standard, the spindle tape tension is 0.7-1 kg ,namely 6860-9800 N .According to the Eq.1:

$$P_0 = Q\frac{(d+d_1)}{4l}\tan(\alpha+\varphi) \tag{1}$$

Among them: d is the screw diameter,$d_1$is the inner diameter of the screw, P_0 the spindle tape tension, Q-load by screw thread, α-the thread Angle, φ- friction Angle .Check thread handbook and get: $\alpha = 30^\circ$， $\varphi = 5^\circ 43'$.The maximum of Q is 3000 kg .According to the formula， a maximum of l is 118.76 mm .The screw thread length takes 135 mm considering the need of the actual use screw.

Software design of the test system

Software part of the system includes data acquisition, data processing, display and storage. The block diagram of test system is shown in Fig.5.

System's program is designed in the way of the main menu, primarily for the purpose of the system's expansion[4]. When new features are added to the system, only the content is added in the main menu without the need to make changes to the entire program. The Program includes four modules, data acquisition module, signal analysis module, document management module and display module.

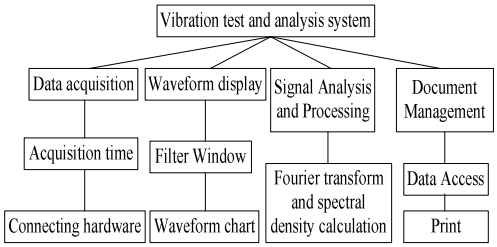


Fig.5. Block diagram of the test system

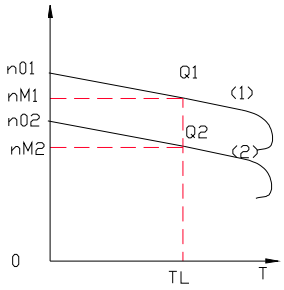


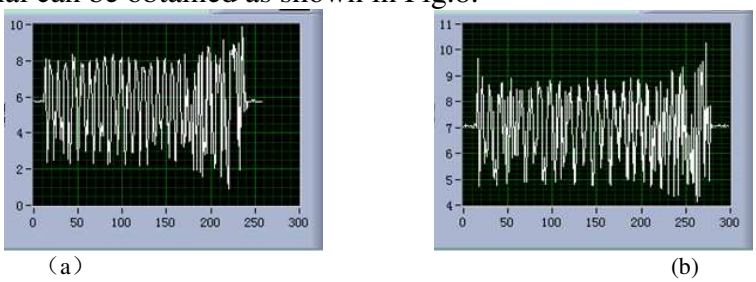
Fig.6 Mechanical properties before and after the frequency control of motor speed

The design of the control system

Control system consists of man-machine interface (touch screen), PLC, ac motor, etc. .By Omron CX - programmer programming software PC sends the MPI programs compiled to the touch screen .Various parameters can be set and modified by the touch screen conveniently .The converter for control frequency control , changes the power frequency, can keep high efficiency, high range, high precision of speed control performance from high to low speed. So the ac speed regulation makes frequency control of motor speed for development direction .Fig.6 shows the mechanical properties of the motor before and after the frequency control of motor speed .The curve (1)in the graph is before speed regulation, (2) after speed regulation.

Spindle vibration test experiment and result analysis

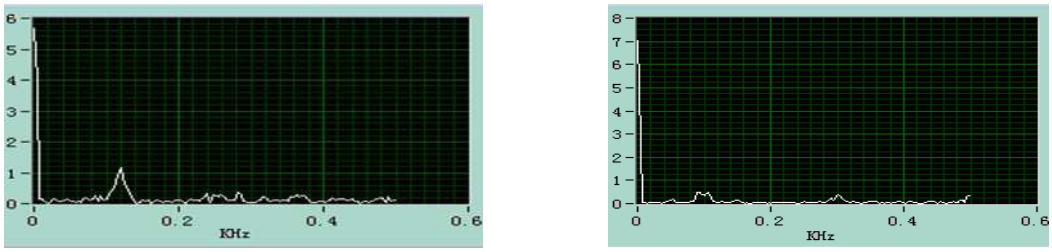
The spindle vibration test system based on Labview is adopted to get spindle vibration signals, amplitude value and make further analysis and processing at the same time .Set the sampling frequency as 100 KHZ, the vibration condition of the spindle were measured in two different rotation speed as 15000 r/min and 20000 r/min , and time domain analysis and frequency domain analysis were completed to extract the vibration characteristics of the spindle[5].Spindle no-load vibration signal is shown in Fig.7.After FFT transform of signal in Fig.7, spindle no-load vibration frequency domain signal can be obtained as shown in Fig.8.



(a) (b)

Fig.7 Spindle no-load vibration time domain signals
(a) the time domain vibration signal of no-load spindle at 15000 r/min
(b) the time domain vibration signal of no-load spindle at 20000 r/min

As can be seen from the Fig.7, the impact of vibration contains certain periodicity, which is the common features of rotating machinery .Vibration amplitude are also increasing with the increase of speed and the corresponding periodic impact component increases and the vibration energy boost .With the increase of rotational speed, the amplitude increases accordingly.



（a） （b）

Fig.8 Spindle no-load vibration frequency domain signals
(a) the frequency domain vibration signal of no-load spindle at 15000 r/min
(b) the frequency domain vibration signal of no-load spindle at 20000 r/min

As can be seen from the Fig.8: in range of 0.09 ~ 0.11 KHz, 0.28 ~ 0.28 KHz, 0.48 ~ 0.5 KHz spectrum peak concentration is comparative obvious .Relevant data shows that the natural frequencies of the spindle blade is about 488 Hz, the natural frequencies of the spindle foot range from 1 KHz to 1.5 KHz, the natural frequencies of the assembly of spindle and frame are about 3.3 KHz .

Summary

(1)The reasonable design of mechanical systems of a set of spindle vibration test can be applied to the state of the spindle speed, and the design of the spindle drive system simulation frame spindle running state .It makes the test results more accurate.

(2) Graphical programming software Labview which is extremely popular in the current measure minefields is used as development platform, so programming efficiency and software quality are improved .It is able to read, store different types of data, complete signal analysis processing in the time domain and frequency domain.It can also extract signal feature correctly.

References

[1] Development and application of spindle vibration test and analysis system based on virtual instrument. [D] Dong Hua University master degree thesis

[2] New trends in the development of ring spinning spindles [J].Textile Machinery

[3] Mechanical Design [M], Beijing: Higher Education Press,2007

[4] Development of digital spindle vibration test system [J]. Dong Hua University

[5] Advantech Corporation. Device Driver’s Manual for USB-4711A.

Applied Mechanics and Materials Vols. 556-562 (2014) pp 2903-2905

doi:10.4028/www.scientific.net/AMM.556-562.2903

The research and design of virtual spindle vibration test system

Dong Fang[1,2], Yang Jian cheng[1,2] ,Gao Tianzhu[1,2],Xie Yu[1,2],Guo Lei[1,2], Zhang Haiyang[1,2],Hu Shiming[1,2],Zhou Guoqing[1,2]

[1]School of Mechanical and Electronic Engineering, Tianjin Polytechnic University

[2]Tianjin Key laboratory of Advanced Mechatronics Equipment Technology, Tianjin Polytechnic University, Tianjin, China

472814117@qq.com

Keywords: spindle; vibration test; Labview; data acquisition; vibration signal analysis

Abstract. In order to facilitate dynamic analysis of spindle, improve the vibration characteristics of the spindle and achieve the goal of control of spindle motion stability. A spindle vibration testing system is developed with necessary sensor, signal conditioner and data acquisition card based on Labview software in this paper. The spindle vibration testing and analysis system is formed based on virtual instrument graphical programming language Labview. The hardware is reduced in testing process. At the same time, acquisition, processing and analysis for vibration signal are realized, and the costs of hardware are greatly reduced. The testing work is made more convenient and quick by this system, and test is made more intuitive by its real-time display function. It will provide a scientific basis for searching for measures to reduce the spindle vibration and developing a new generation of mechanical structure of the spindle.

Introduction

When researching on motion law of spindle, understanding the vibration characteristics of the spindle and improving the operation performance of spindle, the spindle vibration test is a indispensable content. It relates to whether the working of the spindle meets the requirements of the performance of the spindle, realizing goals of high speed, low noise, low power consumption, stable operation and long service life[1] .To facilitate the spindle dynamic analysis, improve the vibration characteristics of the spindle, achieve the goal of control of spindle motion stability, new test methods are needed[2].

A data acquisition and analysis system for spindle vibration signal is formed by using Labview software and data acquisition card in this paper. Test hardware are reduced by using the method that software is the instrument. Collected signals are displayed in the form of waveform and text when the system is in the collection of the vibration signal. An analysis and processing for the vibration signals is done in the time domain, frequency domain, and amplitude domain. Data storage and playback are completed in the file management module. This system is easy to operate, friendly interface, and can be widely used in all kinds of vibration test.

Hardware composition of virtual spindle vibration test system

The spindle vibration testing system centered with the computer system consists of the photoelectric sensor and contains prestige, power amplifier, rectifying filtering measurement circuit, and the piezoelectric acceleration sensor and the pre-amplifier circuit, signal generator, power amplifier, vibrator and related devices, through A converter and A microcomputer and its peripheral equipment.[3] It is widely used for spindle vibration test and the analysis of modal parameters.

Software design of virtual spindle vibration test system

Overall scheme design

In the actual design of virtual instrument, the top-down design method are generally adopted .First of all, according to the system's overall demand, the system is divided into various functional modules .According to the needs of vibration test, in general the program should include at least the following modules: 1, the data acquisition module;2, waveform display module;3, signal analysis and processing module;4, data storage module;5, sensor calibration module;6, the control module .To integrate each module together, a main interface is also needed to design to realize the module calls. The overall scheme of spindle vibration test and analysis system based on Labview is shown in Fig.1.

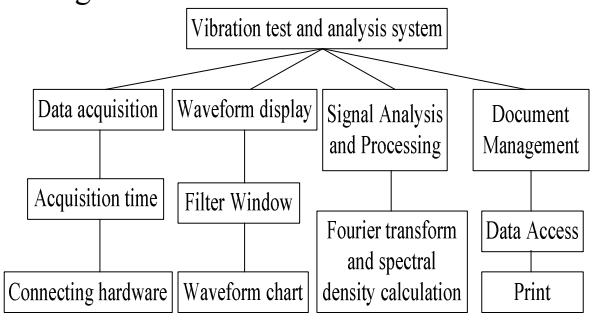


Fig.1 The overall scheme of the test system

Main program design of the system

In the main interface design of vibration test and analysis system, the Edit Menu provided in the Labview is applied. Firstly the function intended to realize conduct as the content of the Menu options, so as to make the runtime call convenient .[4] Then in the block diagram take the call of the Menu of circulation through the Case for choice, making the Menu corresponding to the sub VI. Through the selection of the menu on the main interface to execute a program, makes the program run in the background.

Signal analysis function module

Dynamics analysis of spindle is primarily to test the amplitude of spindle blade, noise and power consumption, etc., and research on their influence factors .In fact, in addition to the above parameters, the vibration of the spindle foot also contains large amounts of information that can reflect the dynamic performance of the whole spindle[5] .Test and analysis of the spindle foot vibration properly, taking corresponding measures, help to reduce the vibration of the spindle, reduce noise and power consumption of spindle, have important meaning on failure diagnosis and elimination, and the structure improve menthe of spindle .

The signal analysis system mainly analyzes the signal auto correlation .The main program mainly adopts a Case structure, a While loop structure. It also controls the type of signal, the frequency, amplitude, phase, the sampling points and sampling frequency. After clicking the upper main interface menu the program begins to run, at the same time making the data in the structure of the loop can be used at any time. Respectively, showing the original signal and the power spectrum, and the auto correlation.

Test results analysis

When the Program is running, the type of Data Acquisition Card is firstly selected before the collection channel.Data is collected, and at the same time signal filtering is performed after the basic parameters of the sampling frequency is set. The collected signal is shown in the form of waveform, and the maximum and minimum of collected data is real-time displayed. When the Save Data button is pressed, data can be saved in the document of the specified path.

The displacement of the spindle vibration can be approximately calculated through sensor calibration, so spindle vibration measurement is achieved. After calibration, the measurements of spindle vibration are shown in Table1

Table1 Table of vibration measurements

Cycle	**Vibration(mm)**		
	Max	***Min***	***Vpp***
1	0.02501	0.01907	0.00594
2	0.02493	0.01877	0.00616
3	0.02404	0.01841	0.00563
4	0.02523	0.01895	0.00628
Average	0.02480	0.01880	0.00600

It can be seen from the data in Table1 that the maximum and minimum reflect the offset distance between spindle top swing and sensor contactor. Peak-to-peak value reflects the vibration of spindle top swing. As the spindle is rotating part, so its vibration will shows a certain periodicity. Vibration data of four cycles which are processed in average are chosen in Table 1. The test results are more accurate.

Summary

Data acquisition and signal analysis system of spindle vibration is constructed in this paper by using virtual instrument development platform of Labview. This system has the following characteristics.

(1)Graphical programming software Labview which is extremely popular in the current measurement field is used as development platform, so programming efficiency and software quality are improved.

(2)A friendly interactive interface is in the system. The test system not only can be used in spindle-line testing of wool, cotton, linen, but also can be used for other rotating machinery.

References

[1] Chen Xiaolan etc. Research of the spindle vibration testing system based on DRVI virtual instrument [J]. Journal of Wuhan institute of technology, 2007, 20 (1) : 58-60

[2] Liu Weili. Situation and development direction of domestic sand spindle [J].Journal of hebei textile newspaper, 2008, 1 (5) : 65-68

[3] Gong Shuzhen Xu Shixu. Programmable controller principle and application [M]. Beijing: people's posts and telecommunications publishing house, 2009

[4] Wang Peng. Data Acquisition and Signal Analysis System for Steam Turbine Vibration Based on the Labview [J].Turbine Technology, 2008, (6): 474-476.

[5] Zero Studio, Liu Gang, Wang Lixiang, Zhang Lianjun. Labview 8.20 Chinese programming and application[M]. Beijing: PUBLISHING HOUSE OF ELECTRONICS INDUSTRY, 2008.

立体织物整体穿刺机穿刺机构运动学分析

摘要： 针对研制的立体织物整体穿刺机碳布穿刺机构,建立其穿刺运动学模型,分析其进行碳布穿刺运动时的运动规律,为其建立穿刺碳布层数与穿刺机穿刺速度关系模型以及碳布穿刺工艺的改进提供理论支撑.

作者： 卢家俊； 董九志； 温晓东； 陆宇； 刘聪乐； 李顶

期刊： 管理学文摘

参考译名： Management Digest

年，卷(期)： 2016，000(005)

页码： 184-186

总页数： 3

正文语种： chi

关键词： 立体织物； 穿刺机构； 运动学； 曲柄滑块