Research on Computer Vibration Test System of Rotating Machinery Based on Wavelet Transform in Auto Parts Inspection

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Abstract. With the development of the automobile industry, the quality of automobile parts has attracted more and more attention. In the process of automobile driving, automobile parts are affected by temperature change, vibration, impact, friction and so on, which will lead to the performance damage of automobile parts. Vibration testing technology is an experimental method which combines theoretical analysis with practical testing. Vibration testing system is mainly used to inspect the quality of automotive parts, and to provide basis for parts optimization. Wavelet change is a new transform analysis method. This paper mainly introduces the theory of vibration. Then, this paper analyses the composition of vibration testing system in automotive parts testing. Finally, computer technology is used to analyze the application of the rotating machinery vibration test system based on wavelet change in vehicle vibration test.

Keywords: Vibration Testing System, Automotive Parts Testing, Test Method, Computer

1. Introduction

Vibration test is a test method based on physical theory and test results. The test is a scientific, efficient and easy to operate detection technology. Based on the knowledge of vibration theory, technicians use matrix theory to calculate the natural frequencies and main vibration parameters of automobile parts. Therefore, through the inverse analysis of vibration theory, technicians can solve the relevant parameters with the actual signal obtained from the test. After validation, the vibration durability of automobile parts is tested periodically, which will ensure the final conclusion of automobile parts testing[1].

There are tens of thousands of automotive parts. Vibration detection of automotive parts can effectively improve the performance of parts, which effectively guarantees people's demand for automotive driving safety. Many parts of automobile need to be tested for vibration detection, such as chassis, body, electrical
appliances, circuit system, etc. For example, the inspection of automobile chassis components mainly includes automobile brake system, clutch bench system, transmission bench system, transmission shaft bench system, steering system test system, etc. Among them, the detection of steering system mainly includes the detection of steering wheel, steering wheel and other parts. Automotive brake system components system includes hydraulic drive parts, pneumatic drive parts, brake hose and so on. The transmission bench system includes many devices, which mainly carry out transmission noise, life and dynamic stiffness².

2. The idea of vibration testing

2.1. Basic concept of vibration

Vibration testing can be divided into sinusoidal vibration and random vibration. Sinusoidal vibration is a commonly used test method in laboratory. It is mainly a test method of vibration, structural resonance frequency and resonance point residence validation produced by ships, aircraft and vehicles through simulation of rotation, pulsation and vibration. Sinusoidal vibration can be divided into sweeping vibration and fixed frequency vibration³⁴. Its severity depends on the frequency range, amplitude and test duration. Random vibration is used to simulate the aseismic strength evaluation of the whole structure of the product and the transportation environment in the packaging state. The severity of random vibration depends on the frequency range, GRMS, test duration and axial direction.

2.2. Principle of vibration testing

In this paper, a simplified forced vibration under harmonic excitation is set up, as shown in Figure 1.

\[ F_s = H \sin wt \]  
\[ m\ddot{x} = c\dot{x} - kx + H \sin wt \]

And then, \( p_n^2 = \frac{k}{m}, 2n = \frac{c}{m}, h = \frac{H}{m} \)

And then, \( \ddot{x} + 2n\dot{x} + p_n^2x = h \sin wt \)

So, \( x(t) = x_1(t) + x_2(t) = Ae^{-n't} \sin(p_n t + \alpha) + B \sin(wt - \varphi) \)

This is a simple harmonic motion.

The amplitude is B.

The phase of forced vibration and exciting force is \( \varphi \).
So, $B = \frac{h}{\sqrt{(p_n^2 - w^2)^2 + (2nw)^2}}$, $\tan \varphi = \frac{2nw}{p_n^2 - w^2}$ \hspace{1cm} (6)

In the formula:

H is the amplitude of the exciting force. $w$ is the frequency of the exciting force. $h$ is the magnitude of the exciting force per unit mass. The phase difference between forced vibration and exciting force is $\varphi$.

![Figure 1. Simplified model of shaking table](image)

3. Composition of vibration testing system

The structural schematic diagram of the vibration testing system is shown in Figure 2.

![Figure 2. The structural schematic diagram of the vibration testing system](image)

3.1. Vibrator

The vibrator is an exciting device. According to the condition of automobile parts testing, he can generate incentives to the object to be tested steadily and continuously. When vibration occurs, we will acquire physical quantities such as vibration displacement, acceleration, frequency and so on. During the test, we will test the stability of the connection between the parts and the vibrator, which is positively correlated with the effectiveness of the excitation transmission\cite{5,6}. 
3.2. Sensor

The sensor belongs to an instrument for measuring vibration. The sensor converts the vibration into electrical signals. Vibration frequency, displacement and acceleration are obtained by transformation and detection. The sensor records and analyses the parameters, which makes a comprehensive judgment on the quality of automobile parts. At the same time, the vibrator will be affected by physical parameters. Technicians analyze the feedback parameters of sensors. By judging the stability of the vibration system, we can get the validity of the test results.

3.3. Amplifier

Amplifier is mainly used to amplify the electrical signal generated by the electrical measurement sensor. Through the signal collector, we can capture the relevant signals. Therefore, the amplifier is used to amplify the electric signal by a certain multiple. Therefore, electrical signals are easily captured by signal collectors. It is noteworthy that the types of sensors are different, and the electrical signals obtained are also different. The amplifier scientifically chooses the voltage signal or current signal according to the type of sensor. If an unsuitable amplifier is selected, it will not only lead to the failure of the test, but also may lead to some adverse consequences. The amplifier makes the vibration test system more stable and effective, and makes the test conclusion more effective.

4. Application of vehicle vibration testing

4.1. Electrometric method

By transforming the measured physical quantity into electrical signal, electrical measurement is a method to measure the electrical signal. The function of physical value and electrical signal value is numerically converted by electrical measurement method, and the physical value is finally obtained. Electrical measurement method can directly obtain electrical signals, which has high accuracy, sensitivity and response speed. Electrical signal acquisition is convenient, its processing and analysis efficiency is high, and the results can be directly displayed on the display screen. Therefore, the electric measurement method can realize long-distance automatic control. In addition, dynamic electrical signals are obtained by electrical measurement. Therefore, the electrical measurement method can obtain the instantaneous electrical signal at a certain time, and also the whole process of the the electrical signal change.

4.2. Mechanical testing method

The carrier of mechanical detection method is mechanical structure, which is used to obtain mechanical signals. After measuring automobile parts by mechanical testing method, the system will produce mechanical energy loss. Therefore, this measurement method has some shortcomings, and it is difficult to ensure the accuracy of measurement results. Therefore, the application of mechanical testing method in automotive parts testing has not received widespread attention.
4.3. Optical measurement

Optical measurement is a measurement method combined with the development of advanced technology. The carrier is an optical sensor. Optical signals are obtained by sensors, amplified and transformed into electrical signals by optical detectors, and then measured and converted by technicians. Finally, we will get the physical value of automobile parts. According to the manufacturing standard of automobile parts, the tester can check whether the performance of the parts meets the standard.

5. Conclusion

Rotating machinery computer vibration testing is of great significance to ensure the safety and stability of the vehicle. In the manufacturing process of automotive parts, reducing maintenance costs is of positive significance for improving the quality of parts, which fully reflects the economic benefits of vibration testing. Therefore, technicians should actively learn computer technology, constantly optimize and update the application of rotating machinery computer vibration testing technology and system, which can promote the long-term development of automobile manufacturing industry.

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