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Study on Inspection Equipment of Working Condition of Tractor

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ABSTRACT

In the vast countryside in P.R.China, most tractors are used as the important transportation vehicles, instead of for field operations. Because performance inspection of tractor is usually ignored, the bad working condition of tractor has resulted in the problems of environmental pollution, energy waste and transportation accidents. Government and agencies various departments of agricultural machinery management have taken measures to inspect the performance of tractor at least once a year. A new-type equipment was developed for the need of managing departments. According to our tests, the accuracy of braking torque is 0.1kg.m, the accuracy of axle weight is 0.1kg, the accuracy of driving speed is 0.01km/h, and the time spending in inspecting a tractor is 3 minutes. More than 150 units can be inspected every day. The test results proved that the equipment was suitable as a moveable inspection tool.

KEYWORDS. Tractor, Working performance, Inspection equipment

INTRODUCTION

There are over 15 million tractors in P. R. China. According to the statistics of Tractor Information Net, the production in 1998 is 1,781,200 units. Tractor is used as a main transportation tool in the vast countryside. Only a small portion of tractors serves for field operations during the busy-season. The tractor contributes greatly to the wide countryside's prosperity.

With the rapid increasing of tractor numbers, the problems of pollution and transportation accident are serious due to bad performance condition of tractor(He,Y.,1999). The performance of tractor decreases and deteriorates quickly if not being often inspected and repaired(Bao Y. D.,1998). In the light of environment protection, energy saving and transportation safety, various departments of agricultural machinery application and management have taken a step to inspect the tractor performance once a year and to improve performance of tractor. A set of suitable test equipment is in need immediately.

STRUCTURE AND PRINCIPLE OF INSPECTION EQUIPMENT

Based on the requirement of administrative department, six main items are inspected in **Table 1**, and the criteria for qualified tractor are showed, taking a typical 8.8kw small-type tractor as example. Among these items, the inspection of the braking performance is mostly emphasized(Li, Z. M., 1996). According to statistics, about 30% transport accidents were due to bad braking performance.

Figure 1 shows four main parts of the equipment: test instrumentation system; data information measuring, gathering and A/D transfers system; microcomputer operation platform and electrical

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and hydraulic control system. The indexes of speed, braking torque and axle weight are measured on self-designed test platform. The indexes of exhausted gas, noise and light are measured by ready-made specialized equipment. The information, either picked up from test platform by sensors or output from the other ready-made equipment, is transferred into microcomputer by RS-232C serial port interaction, and then the data are accepted and processed by self-developed specialized software. Finally, the software program processes data and judges results according to ready-installed criteria, then prints out inspection results. This whole process is displayed online on computer screen.

Table 1 Test report of tractor performance

Driver Name: Vehicle Number: Type: Date:

Speed(km/h)	•40					
Front Axle Weight(g)				Rear Axle Weight(Kg)		
Front Wheel Braking Torque(N·m)	Left			Rear Wheel Braking Torque(N·m)	Left	
	Right				Right	
	Left+Right	•front Axle Weight*40%			Left+Right	•front Axle Weight*45%
	ABS(Left-Right)	•front Axle Weight*8%			ABS(Left-Right)	•front Axle Weight*10%
Lights Power (100cd)	Left	100•LP•220	Result: ×××			
	Right	100•LP•220				
Noise(dB)		•86	Test station:×××			
Exhausted Gas(Rb)		•6.5				

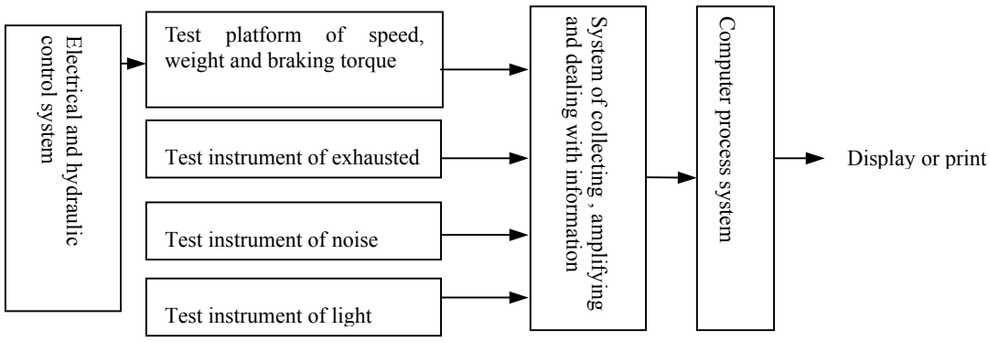


Figure 1 Structure and principle of the test equipment

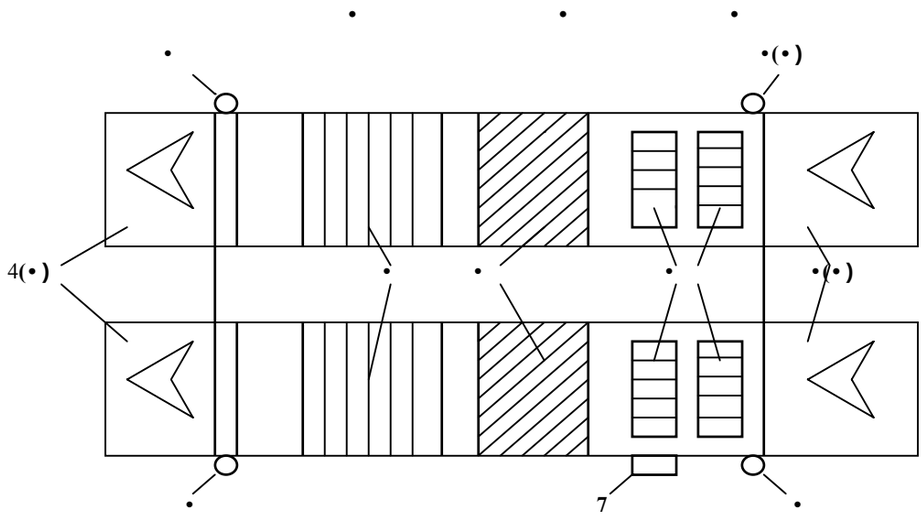
Design of Test Platform and Measurement Principles

Test platform consists of five parts: braking torque test platform(•), axle weight test platform(•), driving speed test roller(•), cylinder(•) and guide deck(•)**(Figure 2)**.

The axle weight is measured by Type CL/YB-2A strain sensor under the platform, in order to be used as a reference to judge the braking performance of the tractor.

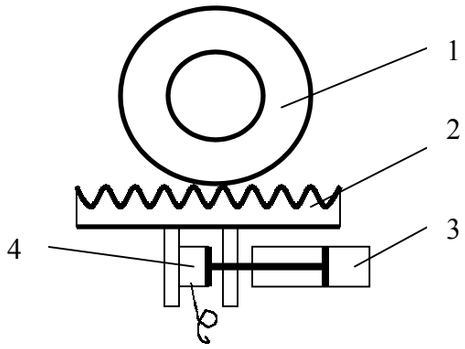
There are usually two methods to test the braking torque. One is that two pairs of rollers driven by electric machine propel the braked wheels of tractor, then the braking torque can be tested by Type CL/YB-2A strain sensor. The other is that the movement of the platform propelled by force from hydraulic pump push the braked wheels of tractor, then the braking torque can be tested by Type CL/YB-2A strain sensor (**Figure 3**). The former has the disadvantages that the worn wheels are difficult to be propelled by rollers so as to affect the testing accuracy, and the structure is relatively complex. The later overcomes above disadvantages, and it is adopted.

The test platform can be lifted by four cylinders fixed on the edges of the test platform. When the four cylinders elevate the test platform to the height higher than the platform of a modified vehicle, the vehicle drive into the point with back gear right under the test platform, then the four cylinders are withdrawn and the test platform set down on the platform of the vehicle, then the test platform can be transported. The height of the four cylinders is 1.5m. The four cylinders can be taken apart and the four guide decks can be dismounted during transportation. The unload process of the test platform from the vehicle is similar to the load process. The test platform is placed on the ground during the operation. The inspected tractor drives according to the procedure, from driving speed test roller to braking torque test platform.



1.Roller 2.Axle weight test platform 3. Braking torque test platform 4•6.Guide deck 5.Cylinder 7.Connction of sensors

Figure 2 Structure of test platform



1.Wheel 2. Movement deck 3. Hydraulic cylinder 4 Sensor

Figure 3 Structure and principle of Braking torque test platform

The index of exhausted gas is measured by Type FQD-102A smokemeter. Noise is measured by Type ST-1 decibel-meter. The indexes of head light are measured by Type GD-I light power correction instrument.

Information Gathering System

The structure of information system is shown in **Figure 4**. It consists of seven pieces of interface adapters, which are the chip microprocessors systems centralized with 89C51 microprocessors. Its functions are mainly amplifying, A/D conversion and processing data from sensors and test instruments. The information from seven interface adapters is collected by communicator, and then transferred into computer by RS-232C serial port interaction.

Development of Inspection Software

Under the Microsoft Windows 95 environment, the computer language of Visual Basic 5.0 was used. Visual Basic is an Object-oriented and Event-oriented computer language. It is popular in the world because of its powerful function and simplicity.

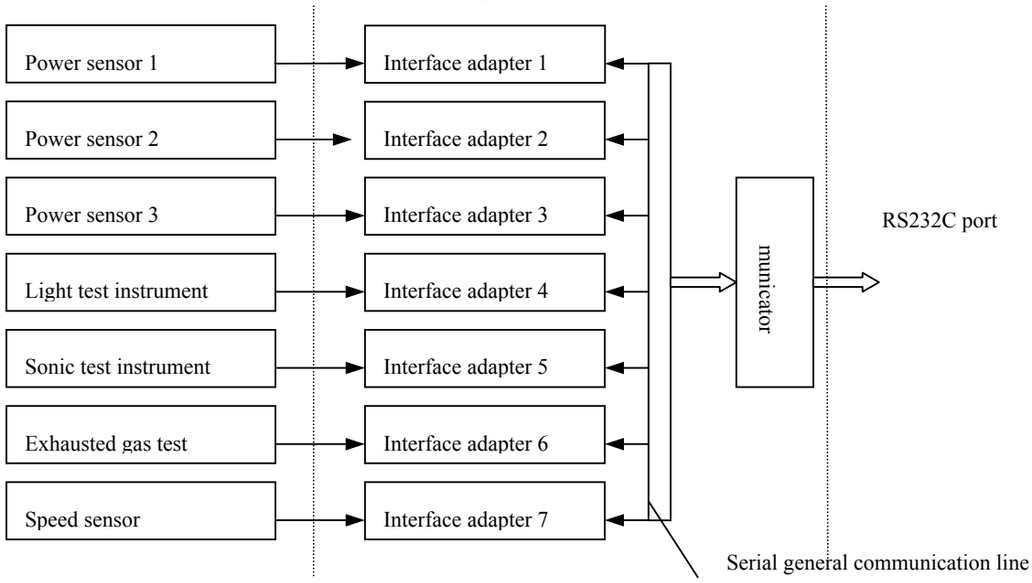


Figure 4 Structure of information gathering

Access 97----a powerful data base management language was used to manage the basic information and the data from test instruments.

Visual Basic provides two methods to fulfill the function of long-distance communication by MS Comm component: a) Event-driven communication; b) Inquiring communication. In this software system, the first method was chosen on basis of concrete condition. Inquiring communication is an effective way to deal with RS-232C serial port interfacing.

The system consists of three main parts (**Figure 5**): Main program(•); Data base file(•); Printing file(•).

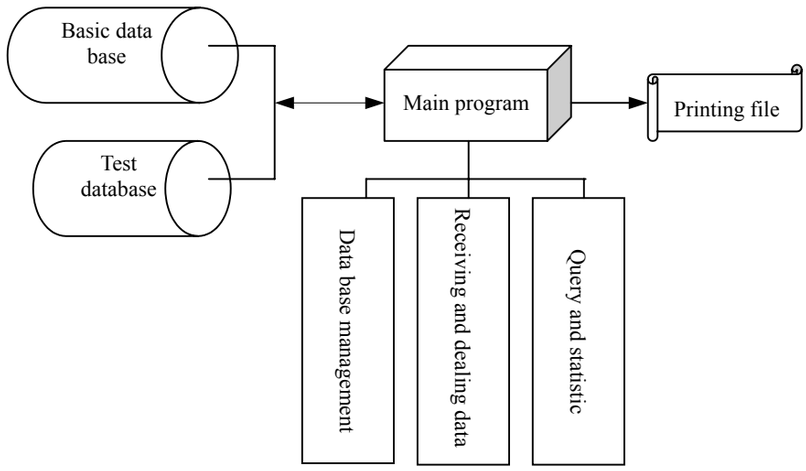


Figure 5 Structure and principle of software system

The software system is important part of inspection equipment. It has friendly and simple operation interface and high operation reliability and can be easily operated even by the people who lack of computer knowledge. The driver can witness the whole test process in the computer screen. Its functions are as following:

- Managing basic tractor information, including to add, query, delete and modify records and to provide some maintenance helps;

- Receiving and preserving the data from A/D boards that converts the data from sensors into digit format, then processing the data and presenting results according to installed criteria. This whole process is displayed online on computer screen;
- Inquiring and printing out statistical inspection results;
- The judgment criteria can be conveniently chosen and modified. The password was set up to adjust the judgment criteria.

TRIAL EVALUATION

Trial of test platform

Test platform includes braking torque test platform, axle weight test platform and speed test platform. Based on the trial, the results of key performance indexes are showed in **Table 2,3** and **4**. The accuracy of braking torque is 0.1Kg.m. The accuracy of axle weight is 0.1Kg. The accuracy of driving speed is 0.01Km/h. The time spending in inspecting a tractor is 3 minutes. More than 150 units can be inspected every day.

Table 2 The results of braking test platform

Criteria	Zero point error	Zero point drift	Error of displayed value	
	•0.1%(F.S)	•0.1%(F.S)/30min	When braking power•4%(F.S) •0.4%(F,S)	When braking power >4%(F.S) •5%(F,S)
Tested value	0	0	0.2%	2.5%

Table 3 The results of test platform of axle weight

Criteria	Zero point drift	Error of displayed value		Repeat error
	•0.1%(F.S)/30min	When braking power•4%(F.S) •5%(F,S)	When braking power >4%(F.S) •2%(F,S)	•2%
Tested value	0	0.5%	0.2%	0.2%

Table 4 The results of test platform of speed

Criteria	Zero point error	Zero point drift	Error of displayed value
	•1Km/h	1Km/h/30min	•3%
Tested value	0	0	0.6%

Mobility Check

Mobility of the equipment is evaluated by the speed and balance ability of test platform being elevated or loaded, and the safety during transportation. According to the trial, the speed of test platform being elevated is 1 minute, and the speed is 0.6 minute/each time. The maximum angle of inclination of test platform during operation is less than 0.2°. The test platform is stable and reliable during transportation.

Analysis on the Inspection Results and Practical Evaluation

The inspection equipment has been practically applied in eight towns in Lingan county, P.R.China. Over 5,000 tractors have been inspected. The average inspection results were as following: the unqualified rate was19%. Among these, failure due to exhausted gas was 1.8%; due to the noise was 1%; due to the light power was 0.2%; due to the braking torque was 7%. The results proved that the performance related to driving safety of the tractors was bad in this region. The management department should take measures to improve the present condition.

According to the results of the practical application, the new-type equipment qualified the designing requirement. It had the advantages of being easily transported and operated, high working reliability and low price. It was proved that this equipment was suitable as an inspection tool.

CONCLUSION

The successful design and development of mobile performance inspection equipment for tractor involved in the complex applications of multi-technologies, such as mechanism, electronics, hydraulic pressure, computer, and so on and it also involved in the specialized knowledge relative to performance inspection of tractor.

The performance inspection for automobile has been done for a long time in our country, but for tractor, it is only in the initial stage. The inspection technology and equipment for tractor need to be developed rapidly.

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