Summary and Research on Inner Surface Inspection of Automobile Brake Master Cylinder

Gui-long Wang* and Bo Yu
Changchun Institute of Technology Mechanical and electrical engineering college, Changchun, China
*Corresponding author e-mail: 200805563@cust.edu.cn

Abstract. In-depth analysis of the importance of the detection of the inner surface of the automobile brake master cylinder, an overview of the inspection status of the automobile brake master cylinder at home and abroad, and a detailed analysis of the detection principles and existing advantages of the current automobile brake master cylinder detection technology. Disadvantages, complete the detection principle diagram of the current automobile brake master cylinder detection system, and finally discuss the research and development and economic benefits of the on-line detection system of the automobile brake master cylinder based on the integration of light, machine, electricity and calculation.

Keywords: Brake Master Cylinder, Inner Surface Inspection, Review Survey, Online Inspection

1. Research Significance
Cars are the most basic and most important means of transportation in today's society. With the continuous acceleration of my country's industrialization and the rapid development of the automobile industry, the number of cars is increasing, and the driving speed is also increasing [1-3]. Therefore, high standards and high-precision inspections for automobile safety performance become more and more important. The braking system is the most important part of automobile safety technology and an important guarantee for automobile driving safety. The main brake is the core part of the braking system. Its performance directly affects the stability of the driving process and the performance of the braking system. Safety is related to the safety of the driver and crew.

At present, the inspection of the inner surface quality of the brake master cylinder by domestic manufacturers mainly adopts direct observation or mechanical measurement methods. However, these detection methods have low detection efficiency, low accuracy, long inspection time and different conclusions drawn by different operators under different production conditions. Therefore, there is no unified standard and standard, so the reliability is not high, and the scale is large. In large-scale industrial assembly line production, the speed of manual inspection is far behind the production speed. At the same time, some mechanical measurement methods need to touch the inner surface of the workpiece for inspection. Secondary wear is very easy to occur during the inspection process, causing unnecessary. In addition, the precision of the mechanical method is limited, which cannot meet the
current precision control requirements for the quality of workpiece manufacturing. Therefore, there is an urgent need to develop a set of non-contact measuring instruments that can meet the needs of my country's automobile safety market and can detect high precision, high speed and intelligent detection.

2. International and Domestic Research Status and Development Trends

In recent years, the investment in precision inspection technology for the inner surface of auto parts has increased, and the precision inspection of geometric dimensions is a research direction that is widely used and has practical value, especially deep hole measurement and blind hole diameter measurement. It is a frontier problem to be solved in the current research field [4-6].

Compared with the outer surface of the workpiece, the detection of the inner surface of the workpiece is more complicated, especially the detection of deep blind hole parts, which is more difficult. Looking back, the inspection technology of the inner surface of the workpiece has gone through three stages before and after: 1) manual inspection; 2) electromagnetic nondestructive testing or ultrasonic nondestructive testing; 3) machine vision testing. In production practice, the first two types of detection technologies have exposed a large number of shortcomings, such as: high labor intensity, poor stability, single detection type, low detection accuracy, etc.

Since the automobile brake master cylinder is an important part that affects automobile safety, its machining accuracy is inherently high. Direct observation and inspection can no longer correctly judge its existing quality defects, and contact measuring tools are easy to scratch the smooth cavity of the master cylinder inner surface. Therefore, the automobile brake master cylinder has always been a difficult part to detect. In the 1990s, with the continuous development of machine vision technology, image processing technology, etc., interactive applications between disciplines became more and more mature. The inner surface inspection technology of workpieces with machine vision as the core was widely used: industrial flaw detection, circuit discrimination and other research fields. Especially the defect detection of high-precision deep-hole parts, using machine vision technology and image processing technology, can display the defect image of the inner surface of the workpiece on the computer in real time. The automobile brake master cylinder compensation hole detection instrument developed by this laboratory can not only analyze the production quality of the brake master cylinder in real time, but also provide an important reference for the industrialization of the system in the future.

2.1 Current Status of Domestic Research

In recent years, my country has made considerable scientific research results in the inspection of the inner surface of the workpiece. Duan Zhanjun of Xi'an Technological University designed an optical system based on the non-destructive inspection of the inner surface of the area CCD component. The optical system has the characteristics of large field of view, small aperture, large depth of field, and small objective lens structure. The imaging is affected by the optical fiber image beam and the resolution of the CCD device. big influence. Figure 1 shows the imaging principle diagram of the detection system [7].
Yang Chen from Taiyuan University of Technology and others studied microwave non-destructive testing of metal pipe surface defects. Metal pipes can be regarded as microwave waveguides, and their surface defects can be judged and located by testing the transmission and reflection characteristics of the vector network analyzer. Figure 2 shows its pipeline inner surface inspection scheme.

**Figure 1.** Imaging principle diagram of the detection system

**Figure 2.** Pipeline inner surface inspection scheme

**Figure 3.** System structure diagram
Chen Fang from Jiangxi Blue Sky University designed a solid engine internal surface defect detection system, which is based on digital image processing technology and pattern recognition technology, and uses an endoscope to detect the internal surface defects of the solid engine. Figure 3 shows the system configuration diagram.

Wang Ying from Beijing University of Chemical Technology conducted research on photoelectric detection methods for the inner surface of thin pipes, and introduced the halo cross-section imaging method, circular structured light visual detection method, and the detection method based on position sensor (PSD).

(1) The halo cross-section imaging method is mainly to project a laser halo to the inner surface of the pipe, and use the information of the inner surface of the pipe reflected by the laser halo to detect cracks and defects. Figure 4 shows the structure of the detection system [8].

![Figure 4. Schematic diagram of the detection system structure](image)

(2) The circular structured light visual inspection uses the modulated light bar information to recover the three-dimensional information through optical triangulation. The narrower the light bar, the higher the measurement accuracy. Figure 5 shows the principle of circular structured light visual inspection [9].

![Figure 5. Schematic diagram of circular structured light visual inspection principle](image)

(3) The PSD-based internal surface detection method uses laser triangulation and optical scanning principles to achieve three-dimensional measurement.

Wang Lei of Changchun University of Science and Technology and others proposed a new type of defect detection system for the difficulty in installation and debugging of precision parts caused by defects such as blisters and cracks on the inner wall of the hole. First, the horizontal motion system drives the probe to the top of the small hole to be measured, and the probe is fixed, then the vertical motion system drives the probe and uses the measurement principle of the endoscope to extract the
image of the inner surface of the small hole, and finally uses Matlab Perform image processing. The results show that the optical probe of this new detection device has a length of 150mm and a diameter of 14mm. It can measure the inner wall of a slender hole with an inner diameter of 15-20mm and a hole depth of 100mm, and can mark the specific location of the defect on the inner wall of the hole. The measurement is accurate and accurate. Strong operability. Figure 6 shows the structure diagram of the detection device [10].

![Figure 6. Structure diagram of detection device](image)

2.2 Current Status of Foreign Research

Compared with domestic smart detection technology, foreign smart detection technology is mature, and the detection accuracy and efficiency are more complete. For example, at the beginning of this century, the American NANOVEA company applied white light confocal technology to successfully develop a three-dimensional intelligent surface profiler, which can obtain the three-dimensional coordinates of the test piece through a single-point scanning method, and then realize the three-dimensional structure analysis; Japan's Kawasaki company The measuring robot produced has great advantages in the field of space inspection. Through the seven-degree-of-freedom attitude transformation, it can realize the internal inspection of complex cavities. It has high inspection accuracy and inspection efficiency. It is widely used in parts of the automobile manufacturing industry. Inspection: A photoelectric equipment company in the United States has successfully developed a photoelectric displacement detection device based on the principle of optical triangulation, which can perform online detection of surface defects and shape tolerances of cylinder blades. The detection accuracy can reach 1.2μm, and the accuracy of the whole machine is about ±5μm; The VG series laser micrometer, which is successfully developed by integrating laser holographic technology and photoelectric coupling technology, has a detection accuracy of ±5 μm; the non-contact diameter measurement system developed by Canon has a detection resolution of ±0.1 μm and detection accuracy And high; a British company developed a deep hole measurement system, which can achieve deep hole measurement with a depth of 12m and a diameter of Φ40-308 mm, with a measurement accuracy of 0.003mm.

The above examples represent the advanced technology of workpiece inner surface inspection, and at the same time, it also reflects the wide range of application fields and development space of machine vision. Modern detection technology based on the integration of light, machine and electricity will gradually replace manual detection and mechanical detection, thus becoming the main direction of future development.

3. Application Prospects
The automobile brake main compensation hole detection system to be studied in this subject is an example of the development of optomechanical integration technology, and a typical application of optomechanical integration technology in production practice. With the development of industrial technology, industrial technology and optoelectronics the integrated technology will also become more mature. At the same time, this topic is also a new development of measurement technology. The application of microsystems and optical systems to measuring instruments will greatly improve the measurement accuracy of the inspection system and enable the inspection of parts. More and more sophisticated, thus driving the development of industrial technology, from the overall analysis of the subject, its economic indicators are better.

References
[1] Matthew Coombes, William Eaton, Wen-Hua Chen. Machine Vision for UAS Ground Operations[J]. Journal of Intelligent & Robotic Systems, 2017, 88(2-4).
[2] H.Golnabi. Design and application of industrial machine vision systems[J]. Robotics and Computer Integrated Manufacturing, 2007, 23(6).
[3] Shanker C. Subramanian, Swaroop Darbha, K.R.Rajagopal. A Diagnostic System for Air Brakes in Commercial Vehicles [J]. IEEE Transactions on Intelligent Transportation System, 2006, 7(3):360-376.
[4] C.L.Bowlin, S.C. Subramanian, S. Darbha, et al. Pressure control scheme for air brakes in Commercial Vehicles[J]. IEEE Proc. Intell. Transp. Syst, 2006, 153(1): 21-32.
[5] Gunduz K, Avsever H, Orhan K, et al. Comparison of intraoral radiography and cone-beamcomputed tomography for the detection of vertical root fractures: an in vitro study[J]. Oral Radiology, 2013, 29(1): 6-12.
[6] Gordon V S, Staub J E. Backcross introgression of plastomic factors controlling chilling tolerance into elite cucumber (Cucumis sativus L.) germplasm: early generation recovery of recurrent parentphenotype[J]. Euphytica, 2014, 195(2): 217-234
[7] Yang S W, Lin C S, Fu S H, et al. Lens Sag Measurement of Microlens Array Using Optical Interferometric Microscope [J]. Optics Communications, 2012, 285(6):1066–1074.
[8] Veiga A, Grunfeld C M, Pasquevich G A, et al. Self-tuning digital Mössbauer detection system[J]. Hyperfine Interactions, 2014, 224(3): 73-81.
[9] Barman S. Performance Evaluation of Multi-Axis CNC Machine Tools by Interferometry Principle using Laser Calibration System[J]. Journal of the Institution of Engineers, 2012, 93(2):151-155.
[10] Ni J, Huang P S, Wu S M. A multi-degree-of-freedom measuring system for CMM Geometric errors[J]. Transactions of the ASME, Journal of Engineering for Industry, 1992(114): 362-369.