

## Causes and Diagnosis of Automobile Mechanical Faults Based on Mechanical Deformation

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### Abstract

*With the increase of the number of people's household cars, people pay more attention to the maintenance of car failures, and people's safety awareness is constantly improving, so safe travel has become a basic and important requirement for people. In road traffic, the probability of traffic accidents is getting bigger and bigger, and most of the accidents are caused by mechanical failure of automobiles, except for the unskilled driving skills of drivers in the internship period. Cars can not only improve people's travel conditions, but also bring people various troubles. Without paying attention to the daily inspection and maintenance of cars, many kinds of mechanical failures will occur in cars. Fault diagnosis is a process of diagnosing the running state and abnormal situation of equipment and determining the general location of faults. This paper analyzes the causes of automobile mechanical failure, studies the key technologies of automobile fault diagnosis and maintenance based on mechanical deformation, and puts forward preventive measures for automobile mechanical failure.*

**Keywords:** Mechanical failure, Automobile, Repair, Diagnosis

### I . Introduction

The mechanical failure of the vehicle during operation is the final result of the comprehensive action of many factors. The mechanical failure of the vehicle leads to the decline of safety performance and ride comfort performance [1]. With the development of science and technology, people's quality of life has been greatly improved, and people have higher and higher requirements for automobile standards. As a means of transportation, automobile brings great convenience to people's travel and plays an extremely important role in people's daily work, production and life [2]. The automobile is composed of hundreds of mechanical parts with complex structure and poor working conditions. Mechanical failure is inevitable due to improper use and wear of parts [3]. The service conditions of the car are very bad. When completing the work in the open air, it must not only withstand the changes of weather conditions, such as cold, warm, rain, snow, wind and sun, but also withstand the drastic changes of temperature and violent vibration. Automobile maintenance practice has proved that arbitrary disassembly and disassembly of automobile assembly or mechanism will have an adverse impact on its working ability [4]. Abnormal disassembly is easy to cause most of the mating pairs to be damaged when they are still in normal state, affecting their working performance [5]. In the long-term driving process of the vehicle, the internal parts will certainly have more or less mechanical failures. In case of mechanical failure of auto parts during driving, the light one will break down on the road, delay time, and the heavy one will be damaged and killed, resulting in major production safety accidents [6].

The automobile composed of thousands of parts and assemblies is a very complex technical system. After the automobile is put into operation, all parts are affected by various complex factors, which will cause the continuous decline of mechanical technical performance and technical status, and gradually move away from the ideal state [7]. As the service life of automobile parts is limited, although the occurrence of mechanical faults is random, the occurrence of mechanical faults generally increases with the growth of automobile service life [8]. Therefore, we must pay enough attention to automobile mechanical faults. In daily life, people pay special attention to the safety performance of vehicles. Doing a good job in the cause analysis and diagnosis of vehicle equipment faults is an

important measure to reduce traffic accidents, ensure that the vehicle runs in a healthy state, improve the safety performance, economic performance and comfort performance of the vehicle, and provide a guarantee for the vehicle to run in the best state [9]. Fault diagnosis is the process of diagnosing the equipment operation status and abnormal conditions, and determining the general location of the fault. After the location and cause of automobile mechanical fault are diagnosed, the maintenance technology is used to eliminate the mechanical fault in time, so as to improve the operation stability and efficiency of the automobile and prolong the operation life [10]. At this stage, reducing automobile faults, improving automobile mechanical fault diagnosis technology and improving quality and effect in maintenance are important ways to ensure automobile safety performance [11]. This paper analyzes the causes of automobile mechanical faults, studies the key technologies of automobile fault maintenance and treatment based on mechanical deformation, and puts forward the preventive measures of automobile mechanical faults.

## II. Causes of Automobile Mechanical Failure

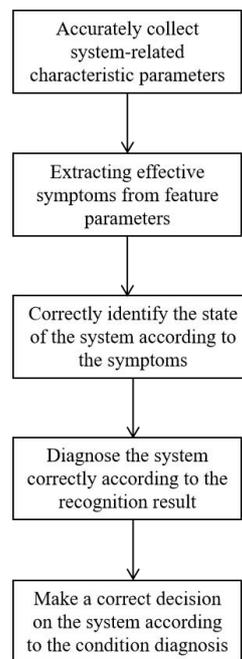
There are many mechanical parts of automobiles, which play their roles under the unified command of the control system. After the mechanical failure, the automobile can not run normally, which usually shows that the brake fails or the gear position reacts slowly, the friction sound, collision sound or vibration of parts make rhythmic sound, and the exhaust gas is very pungent or black smoke. More seriously, the automobile cannot start or cannot run after starting. The composition of automobile is complex, in which mechanical parts account for the main composition, so it is very important for the maintenance of machinery, which is an important guarantee to ensure the safe and good driving state of automobile. Long-term overload and high-frequency operation of automobiles will lead to failures such as ineffective braking and tire burst. At present, many car owners lack the correct awareness of using the car, which makes the car in a situation of excessive workload for a long time and increases the frequency of car failures. There are certain signs before the mechanical failure of automobiles, but some drivers only drive, pay attention to speed and fuel consumption, and do not know much about the safety performance and operation status of automobile parts, so they can not find out the failure in time, and lack of regular inspection of automobile operation, which finally leads to the occurrence of automobile failure [12]. Some second-hand cars have mechanical faults, and it is easy to have traffic accidents when running second-hand cars with mechanical faults without knowing it. In addition, overloading and irregular driving of automobiles are also prone to accidents. The automobile is composed of many parts, and the assembly structure is complex. The models, types and materials of the parts are various, the quality is uneven, and the service life and safety factor of different parts are different. Some parts instantly exceed the maximum load, causing damage, and some parts cannot be replaced in time after damage.

Cars are driven by drivers. In the actual driving process, many drivers have insufficient awareness of safe driving, such as overloading, overtaking, speeding, rapid acceleration, sudden braking and so on. These behaviors will lead to accelerated aging and wear of automobiles, and increase the failure rate of automobile mechanical parts. A variety of parts are used in the manufacturing process of automobiles, but their actual service life is quite different. Many parts are vulnerable and need to be replaced in time. In order to save money, many car owners fail to carry out car maintenance and replace auto parts in time according to relevant regulations, resulting in auto mechanical failure. The running status of automobile is related to the overall performance of parts. In the process of automobile running, the faults caused by the types, specifications, tensile strength and other properties of various mechanical parts are common, and the faults caused by the quality of parts are generally sudden, causing great damage to the overall mechanical operation of the automobile. Mechanical failure of automobile, if not repaired in time, not only has potential safety hazard, but also may cause more serious failure. Automobile maintenance is a new process of automobile maintenance and nursing. Through maintenance, adjust or replace the parts and take the initiative to eliminate hidden dangers. In the process of running, the car needs regular maintenance according to regulations, so as to ensure the effective running and safe performance of the car, find out the mechanical faults in time, analyze the causes and diagnose them, which can effectively prevent all kinds of problems. This requires that the maintenance personnel of automobiles have excellent professional quality, accurately grasp the running status

of automobiles, and judge the faults of automobiles.

### III. Fault Diagnosis Model

By observing the appearance of the automobile, if there are any abnormalities, such as the inclination of the automobile when parked on a flat road, abnormal wear and scratch of tires, loss of parts, etc., the driver should be vigilant. No matter what part of the component, no matter what degree of failure occurs, it will lead to the change of the whole system function, and this change will be directly manifested in the change of parameters. I feel that the temperature is too high during driving, or I stop for inspection in the middle. When I touch the temperature of various parts of the vehicle with my hands, such as the brake drum, tire, rear axle housing, transmission housing, etc., the temperature is unbearable for my hands, which indicates that the car has a fault [13]. The gap of each part of the car has its standard value. If the gap is too large or too small, it indicates that there is a fault. There are standard ranges for all kinds of fuel consumption of automobiles. If the fuel consumption increases obviously, it shows that there are hidden faults in automobiles. Because the automobile system is huge, the parameter information in the running process will be very complex, so in fault diagnosis, we must first extract useful fault features and remove useless parameters. Because the fault can not be directly judged according to the extracted characteristic parameters, it is necessary to further analyze the parameters and extract the fault symptom information. With the above foundation, fault types can be identified and classified. The fault diagnosis process is shown in Figure 1.



*Fig.1 Schematic Diagram of Fault Diagnosis Process*

The trained neural network model is used to detect the special diagnosis of known faults, and the known faults and the detected faults are compared to judge whether the model is accurate or not. When the engine is found to have faults, if the engine has faults, the fault experience database of artificial intelligence database can be used to identify the types of faults. Common faults of fault diagnosis system can be analyzed by virtual simulation, and the empirical database of diagnosis system can be established by using the results of simulation analysis. The state of automobile is related to the environmental temperature, pressure, machine vibration frequency, voltage value, current value and other parameters, and this relationship is very complex, so it is necessary to use neural network for fault diagnosis of automobile uncertainty. Through observation, after understanding the main phenomena of faults, it is necessary to analyze these phenomena deeply and carefully, so as to determine the parts and causes of faults. After using big data to construct fault features, neural network can be used to identify and judge them.

Using neural network subnet, automobile engine faults can be measured from different aspects, and local information fusion can be completed. Using information fusion decision neural network, the diagnosis results of subnet can be output. The fault parameters of automobile engine mainly include fuel supply time, fuel injection pressure, plunger pair sealing and oil outlet valve sealing, etc., and these performance parameters are also included in the vibration signals of the engine. Training samples are input into the network, and after repeated learning and training, a set of weights are generated to call the test samples, so as to predict the characteristics of the target object. The structure of neural network model is shown in Figure 2.

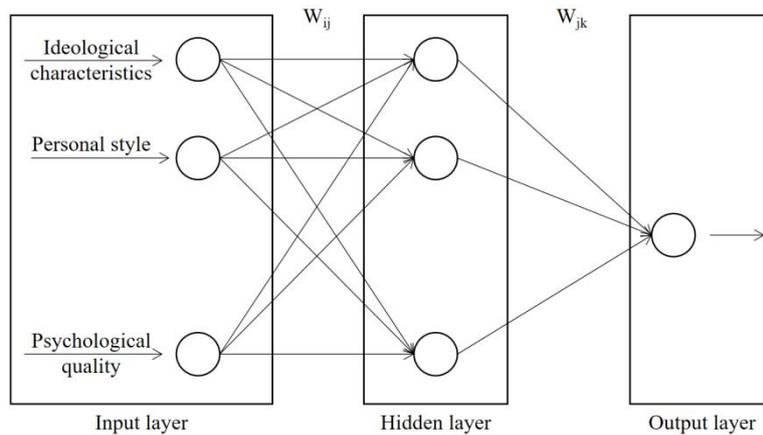


Fig.2 Fault Diagnosis Model

A three-layer BP network can be used to complete any n-dimensional to m-dimensional mapping. The number of neurons in the hidden layer  $s = \sqrt{n + m} + a$ , where n and m are the number of nodes in the input and output layers, respectively. The activation function of the hidden layer neuron is selected as the hyperbolic tangent function, and the function form is:

$$f(x) = \frac{e^x - e^{-x}}{e^x + e^{-x}} \quad (1)$$

The activation function of the output layer uses the Sigmoid activation function, and the form of the function is:

$$f(x) = \frac{1}{1 + e^{-x}} \quad (2)$$

The induced local domain of a certain neuron j in the hidden layer is:

$$v_j(p) = \sum_{i=1}^n w_{ij} x_i - \theta_j \quad (3)$$

The induced local domain of a certain neuron k in the output layer is:

$$v_k(p) = \sum_{j=1}^s w_{jk} v_j(p) - \theta_k \quad (4)$$

In which n and s are the number of neurons in the input layer and the hidden layer respectively. In engine fault diagnosis, multisensor can be used as integrated neural network. In actual fault diagnosis, information fusion

includes local fusion and global fusion, so neural network can also be in series and parallel. In order to find out the main reference that affects the performance, the neural network learning method of artificial intelligence and nonlinear mapping can be used to establish the model of engine parameters and performance evaluation. Each neuron can receive the signal sent from the upper layer, and after processing, it can output the result to the next layer through a related function.

#### **IV. Precautions during Fault Diagnosis**

The automobile is a whole, and every part in it is closely related. Therefore, we can't do random inspection in a chaotic and headless way. We should analyze all possible conditions and make a comprehensive evaluation for the automobile. Automobile mechanical failures are largely caused by drivers themselves, such as improper driving methods and unreasonable driving habits of drivers. Failure or abnormality of any mechanical parts, if not eliminated in time, will not only affect the travel experience, affect the transportation of goods, but also lead to greater failure, leading to dangerous accidents during driving, which directly threatens the safety of life and property. The vehicle mainly updates its own concept, and when it is found that the vehicle has abnormal driving, it can go to a professional repair shop to investigate the problem in time, and repair the mechanical failure in time [14]. Only in this way can the car always be in a good driving condition and ensure the safety and stability of driving. Correct driving operation can effectively protect parts, reduce wear and fatigue damage of parts, and reduce damage of clutch and gearbox, thus reducing mechanical failure. Drivers are usually witnesses of car failures, and drivers should actively think about countermeasures to minimize losses when the car fails. Some standard parameters should be followed when diagnosing cars, which is a crucial point. Parameters are keys to open machinery. In order to better understand cars, we must master some necessary parameters.

#### **V. Conclusion**

A car is made up of a large number of mechanical parts. During the long-time running of the vehicle, the internal parts and components will definitely have more or less mechanical failures. If the mechanical failure of auto parts occurs during driving, it will break down on the road, or the car will be destroyed. There are many reasons for mechanical failure of automobiles, including aging and wear of automobile parts due to inadequate maintenance, excessive load-bearing pressure of automobiles, improper driving operation of drivers, and poor quality of automobile consumables such as lubricating oil and fuel oil. When an automobile inevitably breaks down, we should analyze the cause of the failure quickly and diagnose it accurately, so as to deal with the failure accurately and in time. In the running of automobiles, how to find the mechanical faults of locomotives in time, ensure the safety of driving and reduce the occurrence of traffic accidents is the unremitting pursuit of people. People should constantly summarize the existing diagnostic technologies and comprehensively utilize various new technologies to improve the efficiency of fault diagnosis, so as to better promote the development of automobile industry. Automobile maintenance personnel should actively explore more intelligent methods of automobile diagnosis, and vigorously improve the safety performance of automobiles.

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