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# Present Research and Developing Trends of Automobile Electronic Control Suspension

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**Abstract**: Automotive electronic control suspension advanced suspension system, excellent damping performance, to be more widely used in the vehicle vibration control. This article introduces several new electronically controlled suspension systems. Present research and the trends and development of automotive electronic control suspension recommended.

**Key words**: electronic control suspension; active suspension; air suspension

## I. Introduction

With the improvement of living standards, people have higher requirements for the handling stability and comfort of the vehicle. The vehicle damping system plays an exceedingly important role, and the passive suspension is limited in both brightness and resolution, so the electronic control suspension system was born. It is more adaptive and perfect. With the rapid development of electronic technology, the reliability and life of the vehicle with the microcomputer, various sensors, and actuator have been greatly improved. In order to meet the people's demands for the comfort of automobiles, the major automobile companies have developed an electronic control suspension system (ECS) which improves the comfort of the car. Equipped with ECS, when the car is in a sharp turn, rapid acceleration or emergency braking, we can feel the suspension is more rigid, and feel the suspension is more flexible in regular driving. The electronic control suspension can also balance the ground reaction force, and reduce the impact to the body. Therefore, with the rapid development of automobile electronic technology, various middle grade cars, large passenger cars and off-road vehicles are equipped with ECS.

### 1. Development research of automobile electronic control suspension

In the modern automobile, the electronic control system is used for the active suspension system, which is called the electronic control suspension (ECS). ECS consists of sensors, control switches, electronic control units (ECU) and actuators.

It is a closed-loop control system, according to the vehicle's motion state and pavement conditions, by the acceleration sensor, brake light switch, steering sensor and other detection signal, and the signal is transmitted to the ECU, the ECU for real-time processing, and then to the shock absorber controller issued a corresponding control, the active response control suspension stiffness, damping coefficient size and height. ECU control signal accurately, adjust the suspension stiffness, damping coefficient and body height, so that the suspension system is always in the optimal damping state, and can inhibit and control the body movement. When the inertia of the vehicle brake or the steering is caused by the deformation of the spring, the active suspension system will produce a force which is against the inertia force and reduce the body posture. At present, most of the active suspension system of the electronic control system is achieved by air, hydraulic, electromagnetic fluid to

achieve the suspension. Therefore, the characteristics of the active suspension can be adjusted dynamically according to the changes of the input or the vehicle itself.

At present, the new active suspension system is developed, which has the electronic control hydraulic suspension, the electronic control air suspension, the electromagnetic active suspension, the ABC active body control suspension, and the new BOSE active suspension system.

### 1.1 Electronic control hydraulic suspension

This electronic control hydraulic suspension height can be adjusted manually, and can automatically adjust the stiffness and damping of the shock absorber. The suspension ball replaces the traditional screw spring and the manual control of the vehicle body height, regardless of the number of vehicles loaded with the number of people or goods, the vehicle body height can always remain unchanged. Longitudinal, lateral acceleration and yaw gyroscope sensor at the centre of gravity used to collect body vibration, wheel bouncing, heeling condition and acceleration signal, and then the signal is transmitted to the electronic control unit ECU, ECU send commands to control the servo motor and the four cylinder is pressurized or pressure relief, to maintain the appropriate shock absorber damping and sufficient support[1].

The process of damping force and spring rigidity of electronic control is that ECU can change the elastic coefficient of suspension spring and shock absorber by computer automatic and manual switch. According to the driving conditions, ECU automatically adjust shock absorber and damping force to eliminate vehicle traveling in the imbalance by controlling the strength of the buffer, and make the vehicle to maintain steady state in a bumpy road and automatically adjusts the vehicle to ensure the ride comfort in emergency braking forward and accelerated the fade away,. This suspension provides two modes of sport and comfort for selection, and improves the calculation speed of the electronic control unit ECU.

### 1.2 Electronic control air suspension

The hardware and software of the electronic control air suspension can be adjusted. It is used of air springs and shock absorbers to provide better comfort and body height. In order to change the height of the vehicle, it is the principle of air compressor to provide compressed air, and the compressed air is sent to the air chamber of the spring and shock absorber. According to the output signal of body height sensor installed in the vicinity of all wheels, ECU determine the height of the vehicle and control of the compressor and the exhaust valve, so that the compression or elongation of the spring, so as to achieve the purpose of controlling vehicle height[2].

Take the electronic control air suspension system of TOYOTA LS400 as an example; the vehicle suspension is electronic controlled air suspension[3]. The spring stiffness and vehicle height control can automatically by the driving condition control, and shock absorber is also controlled by the ECU to suppress the vehicle roll, break front nod and speeding up[4]. Therefore, it can be to significantly improve vehicle the handling stability and comfort.

### 1.3 electromagnetic active suspension

When the current is switched on, the magnetic flux of the magnetic fluid in the shock absorber is arranged in a row, and the shape of the liquid is changed in the shock absorber. Therefore, the damping of the shock absorber is hard and can be changed with the magnetic field strength. Magneto rheological damper has the advantages of simple structure, the microsecond rate of reaction and move 1000 times per second. This is general active suspension is difficult to achieve, and also will rise to the occasion at high speed. In addition, the magneto rheological shock absorber on the vehicle is low power requirements (each shock absorber is 20W), which almost no loss of engine power[5].

**1.4 ABC active body control suspension**

Active body control suspension (ABC) is a more advanced active suspension system. It is through the induction of a slight wheel and body movement before the vehicle has any larger body vibration, and adjusts the suspension system in time to maintain the body's balance, referred to as the active body control suspension[6]. The system can be well adapted to various road conditions, and the vehicle can keep good maneuverability, comfort and direction when driving on uneven pavement.

**1.5 The new BOSE active suspension**

The new Bose active suspension uses a linear magnetic motor to replace the traditional shock absorber and the spring device at each wheel. With the compression amplifier is powered to provide power to the motor each time. The main advantage of this kind of motor is that they are not limited by the inertia of the traditional hydraulic damper. Therefore, the linear motor speed of the motor is much faster, so that the vibration of the car is almost completely eliminated. The movement of the wheel can be controlled so well that no matter what happens to the wheel, the car body can be kept stable. Linear magnetic motors can also offset the vehicle acceleration, braking and turning when the body movement[7]. There are many new springs and shock absorbers, but in the past few decades, the basic design of automotive suspension has not been a major breakthrough. With the introduction of Bose new suspension design concept, it may make changes in the automotive suspension design. Bose suspension is independent suspension available to the maximum progress in the field of automotive suspension.

## II. Developing trend of automobile electronic control suspension and suggestions

**2.1 Developing trend of automobile active control suspension**

Semi-active suspension performance is slightly less than the active suspension, but it has the advantages of simple structure and low cost. Semi-active suspension is still the main research direction at present. Semi-active suspension is to develop a reliable, easy to adjust the implementation of the algorithm and the simple and effective implementation of the strategy in the future. The electronic control active suspension is the suspension future development direction. Because of its high cost, the structure is complex, needs the extra control power and so on, it is only equipped with advanced cars and off-road vehicles. At present, the research of active suspension is focused on the reliability and the optimal parameters of the suspension system.

**2.2 Suggestions for automobile electronic active suspension**

(1) Comprehensive application of control strategy

The electronic control suspension needs to control the suspension parameters, and many control methods are adopted such as sky-hook control, PID control, optimal control, adaptive control, neural network control, sliding mode variable structure control, fuzzy control and predictive control. Therefore, it is necessary to study the control method and control theory based on the type of vehicle, the suspension structure and the type of shock absorber.

(2) Study on the joint control of the other system and suspension system of the vehicle

Because the body movement is not a system of individual decision, it is decided by the joint action of multiple systems. When the vehicle is driving under different conditions, the movement of the chassis subsystem (suspension, steering and braking system) has a certain mutual influence and effect[8]. If it is only to study the control of active suspension, and not to study the interaction between each subsystem, it cannot meet the requirements of the development of the car. In the future, we should pay more attention to the integrated

control of the electronic suspension system and the steering system, the brake system.

(3) Optimal parameter control of suspension system

According to vehicle comfort, safety optimization design requirements, and the use of vehicle dynamic model, we can study the vehicle suspension system, and the mutual restraint of vehicle vibration acceleration, vehicle dynamic load and suspension dynamic deflection and other parameters analysis. We can establish the mathematical model of the optimal control parameters for the vehicle suspension system in different speeds, different roads, different vehicle parameters and different vibration conditions. We combine the model with the control of the active suspension system, and the parameters of the suspension system can be adapted to the vehicle, so that the vehicle can achieve the best vibration reduction effect and meet the requirements of the vehicle ride comfort and handling stability. This should be the basic problem of research on the design and control of active suspension system, which can be used to promote the active suspension system.

(4) We strive to study the development of high efficiency energy saving suspension and the electronic control suspension, as far as possible to recover and convert the vibration energy and reduce the dependence on external energy.

## III. Summarize

Along with the progress of science and technology and economic development, it is also increasing that people's demand for stability and comfort of automobile. The active suspension system with superior performance will also be developed and applied. The future will continue to have low cost and superior quality of the active suspension products appear. The active suspension system is no longer a senior car patent, and ordinary cars will also more and more active suspension system.

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