Analysis of EBD Based on Active Safety Technology of Automobile

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Abstract. Recalling the development of automobile safety technology, the development status of active safety technology for automobiles is described. The typical active safety technology of modern automobiles—EBD and other characteristics are analyzed and evaluated. The development trend of automobile safety technology in the future is briefly introduced.

1. Introduction
In our country, with the development of society, traffic safety issues are becoming more and more prominent. Road traffic accidents have become a major social hazard. It seriously affects people's normal life and economic growth.

2. Relevant theories of automobile safety technology
The history of automobile development is the history of continuous improvement of automobile safety performance. The development process of automobile safety technology is also the process of development and perfection of automobile safety technical regulations.

2.1. Definition of traffic accidents
China defines road traffic accidents as: “In the course of specific road traffic, traffic incidents are lost because the parties violate traffic regulations or should bear responsibility according to law.” Participation of vehicles is a prerequisite for defining the location of traffic accidents. Ensuring automobile safety is the main link to reduce accidents.

2.2. Overview of Vehicle Safety

2.2.1. Vehicle safety comes into being with the invention of automobiles and is the inevitable product of the invention of automobiles

2.2.2. Vehicle safety mainly depends on vehicle, human and traffic environment. First of all, the reliability of the car should be high. Safety performance is good. Secondly, people who participate in traffic behavior should master traffic safety knowledge. Comply with traffic regulations; In addition, whether the traffic environment (road, traffic facilities, and regulatory management) is good or bad or not. It also plays an important role in ensuring the safety of automobiles.
3. The purpose of studying EBD

3.1. Overview of EBD

EBD can vary according to the axle load transfer due to braking. The braking power distribution ratio of the front and rear axles can be adjusted automatically. Improving braking efficiency, improve braking stability with ABS.

Automobile braking stability directly affects vehicle safety. The braking stability is closely related to whether the wheels are locked and the order of the front and rear wheels. Front-wheel-locked vehicles will lose steering ability. When the rear wheel is locked, side slip or even tail flick will occur. The consequences are even worse. Traditional automobile braking systems usually limit the braking power of the rear axle by adding a proportional valve between the front and rear axle braking lines. In order to avoid the lock side slip of the rear wheels when braking. But the adhesion utilization rate of rear axle is still not the best. The attachment loss is shown in the shadow section of Figure 1.

Figure 1. Distribution Curve of Braking Force for Front and Rear Bridges with Proportional Valves

EBD uses electronic technology instead of traditional proportional valve to control braking force distribution of front and rear axles of automobile hydraulic braking system. Its basic idea is to increase the rear wheel braking force as much as possible. The motion of wheels is monitored by sensors. Once it is found that the rear wheel has a tendency to lock up, the electronic controller controls the hydraulic brake to reduce the braking pressure. Because of the high frequency, small amplitude and precise control of EBD, it can make the beta line always below the I line and infinitely close to the I line.

So EBD ensures braking stability at the same time. The maximum braking force is obtained for the rear wheel. Thus, the braking efficiency of the whole vehicle is improved.

3.2. The relationship and advantages of EBD and ABS

EBD is an auxiliary system of ABS. Functions are added on the basis of ABS system. The performance of EBD-loaded vehicles is much higher than that of ABS-only vehicles. EBD has no hardware additions to ABS. It is only the optimization and enhancement of control procedures and functions. Through improvement, the software control logic of ABS computer is enhanced. Make the operation more complex. EBD can brake according to the movement of each wheel of the vehicle. Intelligently distribute the braking force of each wheel. In order to maintain the stability and direction of the vehicle in braking state. Moreover, even if ABS fails, EBD also ensures that there will be no malignant events such as overturning caused by tail flick.

EBD starts to control the braking force when the car brakes. Both ABS and EBD control the moment acting on the wheel. It can prevent the wheel from sliding relative to the road surface. In order to make full use of the adhesion coefficient of pavement, To prevent the vehicle direction from losing control due to the additional steering moment caused by different adhesion coefficients between left and right roads. Although ABS guarantees the stability of rear wheels, But the comfort of ABS is poor while EBD only uses slip rate. The slip threshold of EBD is lower than that of ABS.
3.3. Composition and working principle of EBD

3.3.1. Composition of EBD. The EBD system consists of a speed sensor, Electronic controller and hydraulic actuator are composed of three parts. The speed sensor is mounted on four wheels. Measure the wheel speed. Hydraulic actuator is mainly controlled by the constant open valve of rear axle pressure. Constituted by an atmospheric closing valve and a low-pressure accumulator, The function of low pressure accumulator is to temporarily store brake fluid discharged during depressurization. The electronic controller receives the speed signal. Based on these signals, the reference speed and slip rate of the vehicle are calculated. When it is recognized that the rear wheel has a locking tendency, that is, the slip rate is greater than a certain value, The controller signals the solenoid valve in the hydraulic actuator. The braking force of the rear wheel is reduced to ensure that the rear wheel will not be locked.

3.3.2. Hardware and Software of Electronic Controller

![Figure 2. Hardware block diagram of EBD electronic controller](image)

The power transformer in Figure 2 converts the 12V voltage of the automobile power supply into the 5V voltage of the processor. After filtering, the speed sensor signal is transformed from sinusoidal analog signal to a series of rectangular pulse signal by trigger. In this design, two microprocessors (processor I and processor II) are used. Considering that the brake system is an active safety component, so redundant design is adopted. Two processors control operations with the same control logic. The control signal will be sent to the solenoid valve drive circuit only when the output of the two processors is identical. At the same time, the monitoring signal of the solenoid valve is sent back to the processor through the feedback circuit of the solenoid valve signal. To ensure that the solenoid valve works in an effective state. Two processors exchange data with each other to monitor each other. The two watchdogs are identical in structure. But they operate independently of each other. The program running in the whole process monitoring processor, Initialization of control processors, Identify overvoltage and undervoltage faults. The negative pole of the power supply is disconnected by the power drive circuit when the function failure is found. Once the fault is found, the warning light driver circuit will light the warning light.

4. Research status of EBD

4.1. At present, the control of EBD mostly adopts single control mode such as logic threshold method. It is difficult to eliminate the influence of complex braking conditions on the control system. The EBD hierarchical control system for automobiles is designed. Four local fuzzy controllers at the
control level calculate the pre-distributed braking force of four wheels respectively. The coordination controller in the coordination level adjusts the pre-distributed braking force. The best braking force distribution can be obtained for each wheel of the vehicle. Before analyzing the EBD hierarchical control system of automobiles, we need to fully analyze the mechanical characteristics of tire-ground contact during vehicle braking.

4.2 Calculation of Reference Vehicle Speed and Reference Slip Rate

The reference speed is calculated according to the signal of the wheel speed sensor. It is very important to achieve EBD control. And this method should be universal. A large number of wheel speed curves of ABS for various vehicles are obtained in the experiment. After data processing and analysis, it is found that under the premise that the wheels are not locked, when different vehicles with different tires brake on different roads, the basic law of wheel speed curve change is consistent. According to the relationship between braking pressure, wheel speed and ground adhesion, the variation of wheel speed can be divided into three states: boosting, decompression, and holding. The change of wheel speed reflects the mechanical characteristics of tire-ground contact during braking. At the beginning of braking, the speed of the car is higher and the same as that of the wheel. In order to shorten the braking time, the braking force should be increased. At this time, the wheel speed drop rate is the largest. With the rapid decrease of wheel speed, in order to prevent the wheel from locking, the braking pressure should be reduced. The reduction rate of wheel speed decreases; if the pressure is reduced further, it will be disadvantageous to make full use of the adhesion coefficient of the road surface for braking. Therefore, it is necessary to adopt pressure-holding method. But if the pressure is kept too long, the wheel speed will rise again. When the recovery reaches a certain level, the next braking cycle starts again. Therefore, a general method for calculating the reference speed is proposed, which is based on the connection between peak and peak values of wheel speed. Drawing is shown in Figure 3.

![Figure 3. Peak Connection Method for Reference Vehicle Speed](image)

Experiments show that the EBD hierarchical control method can coordinate the braking force distribution of the whole vehicle before the ABS control takes effect. Make full use of the adhesion between the wheel and the ground. The braking stability of the whole vehicle is good because of the consistency of the locking of each wheel. It is an effective new EBD control method. It can solve the braking force distribution problem of the whole vehicle. It grasps the essential characteristics of the early braking stage of automobiles. It only needs to measure the speed of four wheels. No precise vehicle braking dynamics model is needed. The influence of model uncertainty on EBD system is reduced. It can improve the efficiency of development.
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