Research and Implementation of Electric Vehicle Braking Energy Recovery System Based on Computer

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Abstract. The invention and application of automobiles have made important contributions to the development of human civilization. With the innovation of computer technology and the change of people's understanding, the structure, driving system and working efficiency of automobiles are changing and improving. Today, more than 100 years later, cars are still an important means of transportation in people's daily life. Automobile industry has played a great role in contemporary world economic activities, bringing convenience to people's lives, increasing many employment opportunities and bringing huge wealth. It has become one of the pillar industries of world economic development. While automobiles have made great contributions to human civilization, the air pollution caused by automobile exhaust has seriously affected people's living environment. Today's cars on the market use two kinds of energy sources, petroleum fuel and electric energy. In order to solve the environmental problems and energy crisis brought by the development of automobile industry, electric vehicles are favored by governments of various countries and major automobile companies in the world. Because of its advantages of energy efficiency, wide sources of electric energy and environmental protection, an upsurge of developing electric vehicles has swept the world. Today, with the rapid development of electric vehicles, battery life has become a serious obstacle to their faster development. So as to improve the cruising range of electric cars, that is significant to increase the battery quality or energy density, which also greatly increases the cost of electric vehicles and is not conducive to the further promotion of electric vehicles. We can conduct in-depth research on improving the braking energy recovery and utilization rate of electric vehicles. From the perspective of environmental protection, electric vehicles have zero emissions. Even if the exhaust emissions from power plants and other power generation methods are included, the air pollution can still be greatly reduced. The requirements of society for sustainable development and its own advantages make electric vehicles the correct direction for the future development of automobile industry.

Keywords: Computer, Electric Vehicle, Braking Energy Recovery System, Electric Vehicle Construction
1. Introduction of electric vehicles

Electric vehicles refer to vehicles that use electric energy to drive motors in whole or in part, and use motors as power sources in whole or in part. In recent years, the research and growth of electric cars has become the research focus of the troubled governments and the famous automobile manufacturers in the world, and has shown an accelerated development trend in various factors in the world, which are actively promoting the development of electric vehicles. The development of electric vehicles is the core content of Japan's "low-carbon revolution", and the Japanese government plans to popularize 13.5 million clean and low-carbon new vehicles within ten years, with electric vehicles as the first choice. The U.S. government has also actively implemented the Green New Deal, taking the development of electric vehicles as an important part of its national strategy, and plans to popularize 1 million hybrid electric vehicles in the next five years. China has also vigorously implemented the transformation of automobile industry.

2. Relevant research on braking energy recovery system

Braking energy recovery technology was first applied to electric locomotive system, which recovered braking energy during locomotive braking. Brake energy recovery of electric vehicles means that compared with ordinary vehicles, kinetic energy and potential energy stored in the vehicles can only be converted into heat energy by friction brakes and dissipated. When the electric car is in a braking mode, the motor works in the power generation mode to provide a certain torque for braking, and at the same time, it can convert part of its kinetic energy into electric energy and store it, and output power for the motor when the electric vehicle accelerates and runs normally, so as to achieve the purpose of energy recovery and reuse. Braking energy recuperation scheme refers to a control method that makes the braking rotation created by the motor and the braking torque of the friction brake work together in the braking energy recovery system of electric vehicles. While ensuring the braking safety, the braking energy recovery efficiency is improved by optimizing the control strategy.

2.1. the significance of studying braking energy recovery system

Researches on electric vehicles involve knowledge of many disciplines, such as mechanical, electronic, electrical and chemical. At present, the technology of electric vehicle is not mature enough. In view of the current development state of electric vehicle, the research focus of electric vehicle in recent years mainly includes energy storage technology, high-performance driving technology, braking energy recovery technology, vehicle performance optimization, integrated control system development and so on. In this hot spot, the development of energy storage technology needs revolutionary progress of battery technology, and the innovation of battery technology is difficult to complete in a short time. There are two aspects of high-performance driving technology, one is to improve the driving efficiency during the advancement or acceleration of electric vehicles, and the other is an integral part of braking energy recovery technology, which is also the research hotspot of electric vehicles. One part of the research on braking energy recovery system mainly focuses on driving technology, improving the feedback efficiency of motor energy. Optimization of vehicle performance and development of integrated control system are also one aspect of improving the performance of electric vehicles, but overall there is little potential. Through analysis, braking energy recovery technology is the key technology that can significantly improve the driving range of electric vehicles under the current technical conditions[1].

2.2. Development status of braking energy recovery technology at home and abroad

At the initial stage of the new electric vehicle boom, foreign countries attach great importance to the research and application of braking energy recovery system. The research on braking energy recovery technology has gone through the process of theoretical research, laboratory simulation development and popularization and application in actual electric vehicles. In the aspect of real vehicle application, Toyota Company of Japan introduced Prius, a hybrid electric vehicle with braking energy recovery system in 1997. The vehicle carries an energy recovery system, and the vehicle control system
realizes the change of hydraulic braking force after regenerative braking, and reasonably distributes the torque supply ratio of regenerative braking and friction braking in the braking state. In 1999, it also introduced ISG motor. INSIGHT, a hybrid electric vehicle equipped with braking energy recovery system, not only combines hydraulic braking with motor regenerative braking, but also controls the throttle valve of the automobile engine all at once. In terms of braking force distribution, it adopts a dual braking force distribution coefficient control scheme, which improves the recovery efficiency of the braking energy recovery system. Ford Motor Company has also developed the fuel cell steam FOCUS with braking energy recovery system. The energy source of this model is composed of batteries and fuel cells, and the driving range of the car reaches 160-200 miles. The braking energy recovery system plays a vital role in improving the driving range of the car[2].

![Figure 1. insight series cars launched by Toyota.](image1)

![Figure 2. Ford Focus Electric Vehicle.](image2)

In China, major enterprises, scientific research institutions and colleges and universities are doing research on braking energy recovery system, and have achieved certain results, but compared with foreign countries, there is still a certain distance. With the tilt of national policies towards electric vehicles, domestic automobile companies have also increased their investment in research and development of electric vehicles, and have also launched hybrid electric vehicles one after another. However, in terms of braking energy recovery, most of the research in universities and enterprises still stays in the theoretical analysis and experimental stage[3].
3. Structure of important parts of electric vehicles

Battery pack and super capacitor are the energy sources of electric vehicles, and they are also the storage devices for recovering energy during braking. The driving and energy recovery module can adjust the voltage at both ends of the armature of the motor, and control the motor to drive buses and recover braking energy under electric and braking modes. Permanent magnet DC motor is the power conversion device of electric vehicle, and its function is to realize the mutual conversion between electrical energy and mechanical energy, especially when braking, the dynamic energy of the vehicle is converted into electrical energy and fed back to the energy storage element through the transmission system. The main controller and ABS controller are the core control components of the regenerative braking system of electric vehicles. Their function is to coordinate the ABS controller to hand out the braking force reasonably according to the information collected by sensors such as vehicle speed, wheel speed and pedal, and according to the driver's operating instructions, so as to obtain good operation smoothness, power and economy. The main controller is installed above the motor\(^4\).

4. Research on braking energy recovery system

4.1. Methods to improve energy recovery

Traditional fuel vehicles use vacuum boosting system to realize brake boosting, and its principle is to use vacuum of engine intake manifold to provide brake boosting, without consuming engine energy in the process of brake boosting. However, there is no engine in electric vehicles, so the traditional braking assistance mode of fuel vehicles can no longer be used. The braking system of electric vehicle consists of double-circuit hydraulic pipeline, electric vacuum booster and motor anti-drag braking. Among them, the double-circuit hydraulic pipeline is consistent with the traditional fuel vehicle, and its function is to ensure that after one of them fails, the other road can still maintain at least about 30% braking force to ensure braking safety. The biggest difference between electric vehicles and traditional fuel vehicles lies in their braking assistance mode and braking system composition. Since electric vehicles have no engine, they can only use vacuum pumps to generate vacuum assistance. In fact, electric vacuum assistance also belongs to the traditional vacuum assistance system; In addition, the electric vehicle adds motor anti-drag braking to realize energy recovery. Using vacuum pump to generate vacuum boost is essentially equivalent to using engine intake manifold to generate vacuum boost. Because of its low cost and easy replacement, it is widely used in electric vehicles. However, it is difficult to cooperate with braking energy recovery system by using vacuum boost system, so it is difficult to effectively improve braking energy recovery efficiency\(^5\).

4.2. Main constraints during braking

We hope to recover all the kinetic energy of electric vehicles, that is, to recover all the energy after removing the energy consumed by driving resistance. But in fact, the efficiency of energy recovery is very low due to many factors, so it is necessary to analyze the constraints that effect the efficiency of braking energy recovery. In the electric car studied in the article, only the hindermost two wheels are driving wheels, that is to say, the energy recovery system can only recover the braking energy on the rear two wheels, and this braking energy is transmitted to the energy storage system through the driving shaft connected with it. When the braking torque required by braking intensity exceeds the maximum limit of two driving wheels, the safety performance of electric vehicles is more important than the energy recovery performance. So as to ensure the safety of automobile braking, certain braking torque should be provided on the non-driving wheels, which can only be realized by traditional hydraulic friction braking, and this part of energy is dissipated in the form of friction heat and cannot be recovered. At the same time, the braking energy on the driving wheels can not be completely recovered. Under normal braking conditions, the braking torque required on the driving wheels cannot be completely provided by the motor. Because the generating capacity of the motor is limited by its characteristics, and because the maximum regenerative braking torque generated by the
motor cannot exceed the generating capacity of the motor at the current speed, the main limiting factor is the maximum current that the motor can bear. When the braking intensity is high, the braking torque generated by motor regenerative braking alone cannot meet the requirements. When the required braking torque exceeds the range provided by the energy recovery system, the excess torque will be provided by the hydraulic braking system of the driving wheel, and this energy will be converted into heat by the friction braking system and dissipated\cite{6}.

5. Conclusion
Through the above discussion, the research background of braking energy recovery operate scheme is analyzed, and the research achievements of various groups at home and abroad in the field of braking energy recovery are analyzed. The article introduces the power system structure of pure electric vehicle, analyzes the working mode of motor drive system, and analyzes the working state of drive system under braking energy recovery. It can be seen that the cruising range of electric vehicles can be greatly improved by getting better the braking energy recovery efficiency of electric vehicles. By cooperating with traditional hydraulic braking system, low-intensity braking uses all motors as much as possible. On the premise of using motors for reverse drag, medium and high-intensity braking, supplemented by traditional braking system, can effectively reduce the frequency of use of traditional braking system, thus reducing its wear, improving the reliability of braking system and reducing the risk of thermal recession of traditional braking system at critical moments, which is of great significance to improve the braking safety of the whole vehicle.

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