Parameter Optimization of Hybrid Electric Vehicle Based on Multi-condition Optimization Algorithm

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Abstract: Coordinating and optimizing the parameters of hybrid electric vehicle (HEV) powertrain and energy control strategies is the key to improving fuel economy. The HEV drive system parameters have a significant impact on the vehicle's power, fuel economy and emissions performance. For HEV, the reasonable matching of the drive system parameters will directly determine whether the HEV can meet the energy conservation and environmental protection requirements. After determining the design goals and design of the hybrid vehicle, it is necessary to determine the selection of each component and its parameters. In order to achieve the best fuel economy under the condition of satisfying the vehicle dynamic constraints. Hybrid electric vehicle (HEV) is the most feasible product which combines new technology with old technology. It has the advantages of both pure electric vehicle and traditional internal combustion engine vehicle. Based on the multi-condition optimization algorithm, this paper proposes an optimization strategy for the parameters of the power system calculated according to the theoretical knowledge of the vehicle.

1. Introduction

Hybrid Electric Vehicle (HEV) parameter optimization is based on the premise of satisfying the power performance of the vehicle, so that the battery charging state (SOC) of the vehicle can be maintained and the fuel consumption of the vehicle can be reduced after the operation [1]. This is not only related to the design of vehicle power system parameters, but also to the parameters of energy control strategy. For large cities with dense automobiles and heavy traffic, off-design operation of internal combustion engines caused by frequent start and stop of automobiles is the main cause of serious exhaust emissions and high fuel consumption [2]. After determining the design objectives and design schemes of hybrid electric vehicles, it is necessary to determine the selection of components and their parameters. In order to achieve the goal of achieving the best fuel economy under the condition of satisfying the vehicle dynamic constraints [3]. The power system of a hybrid vehicle consists of multiple power sources. Through the control strategy, the reasonable distribution of required power between multiple power sources and the coordinated control between the various components of the power system are achieved [4]. Thereby improving the fuel economy of the vehicle. Hybrid vehicles are currently the most industrialized and promising electric vehicles in clean cars. It uses an engine and battery as a hybrid powertrain to control the engine and battery in the best economic zone.

Hybrid vehicles are complex nonlinear systems that include engines, motors, power batteries, and electromechanical couplings [5]. Coordinating and optimizing the parameters of the hybrid vehicle's powertrain and control strategy is the key to reducing fuel consumption. Due to the nonlinearity and mutual coupling of the components of the hybrid system, there is a conflict between the parameters [6]. The parameter optimization of the hybrid vehicle is based on the premise of satisfying the dynamic performance of the vehicle and the performance constraints of each component. Hybrid electric vehicles are the most viable products that combine new technology with old technology. They also have the advantages of pure electric vehicles and traditional internal combustion engines [7]. Aiming at the fuel economy or power performance of the vehicle, the parameters of the power system and the related parameters of the control strategy are optimized at the same time. The combination of different engine power, motor power, battery capacity and

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battery bus voltage will make hybrid electric vehicles show different power performance and fuel economy [8]. Therefore, it is necessary to optimize the parameters of the power system calculated according to the theoretical knowledge of the vehicle.

2. Hybrid Drive Mode of Hybrid Electric Vehicle

The objective of parameter optimization of HEV power system and control strategy is to keep battery SOC within a certain range and to minimize the fuel consumption of the whole vehicle after the complete operation of the vehicle under the premise of meeting the power demand of the whole vehicle. Engines and motors are connected directly to the drive axle at the same time through some transmission device. The motor can be used to balance the load on the engine so that it can work in the high efficiency area. The objective of power parameter optimization is to reduce fuel consumption and emissions of 100 kilometres on the premise of satisfying the power performance of the vehicle. By formulating the basic energy management strategy of the hybrid electric vehicle, the initial values of the vehicle power system and the control system parameters and the range of values of each variable are selected. When the vehicle is operated under a small road load, the fuel economy of the engine of the conventional vehicle is relatively poor. The engine of the parallel hybrid vehicle can now be turned off and only the electric motor is used to drive the car. The use of logic threshold control methods is appropriate for hybrid powertrain control systems.

The parallel drive system has two energy transmission routes that can use both the electric motor and the engine as a power source to drive the car. Under the premise of meeting the power requirements of the whole vehicle, reducing engine power, increasing battery capacity or bus voltage, can achieve better fuel economy. Hybrid vehicles have a large number of design parameters, and it is not realistic to optimize all design parameters. When low power is required, the electric power is absorbed, and the state of the electric quantity is maintained within a certain range. The parameters of power system and control strategy have an important impact on the vehicle's power performance, fuel consumption and emission. The parameters of power system and control strategy should be taken into account in parameter optimization. By formulating the basic energy management strategy of hybrid electric vehicle, the initial values of vehicle power system and control system parameters as well as the range of values of each variable are selected. The traction force of hybrid electric vehicle can be increased when the electric vehicle starts, climbs or accelerates, and the electric vehicle can also be driven independently.

If the additional benefits from collaboration in multi-condition optimization can be allocated among participants, it is called payable transferable multi-condition optimization. On the contrary, it is called payment non-transferable multi-condition optimization. Power plant is the passive executor of the unified dispatching system. In the electricity market, power generation companies have the autonomy of production and operation, and become the main body of market competition. It will adopt different bidding strategies to maximize profits by adjusting the quotation curve. Fig. 1 is the scanning speed modulation architecture of the power prediction model.

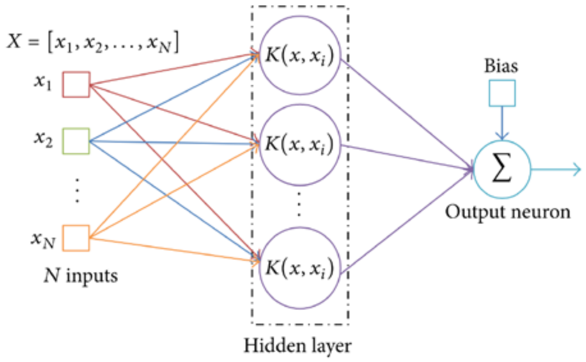

Fig.1. Scanning speed modulation architecture of power prediction model

The goal of optimizing the power source and energy management control strategy parameters is to ensure the vehicle's dynamic performance. Optimize a set of parameters to minimize fuel consumption. Two drive systems can drive the electric car independently. It is also possible to jointly drive electric vehicles to turn electric vehicles into four-wheel-drive electric vehicles. Increasing the battery capacity and bus voltage leads to an increase in cost, which may not offset the cost reduction caused by reducing engine power [9]. The characteristics of different working conditions should be considered comprehensively. Hybrid electric vehicle control strategy optimization objectives are fuel consumption and exhaust emissions, and its measurement indicators are calculated fuel consumption and hydrocarbons, carbon monoxide and nitrogen oxides emissions. In order to keep the difference of SOC between the beginning and the end of each working condition fluctuate within a small range, the difference between the beginning and the end of SOC should not change too much or even fall to the lower limit. Parallel hybrid electric vehicle with combined driving force can be refitted with ordinary internal combustion engine vehicle. The two power systems are not related to each other and can give full play to their respective characteristics.

3. Control Strategy of Hybrid Electric Vehicle Drive System

The driving force combined parallel hybrid electric vehicle has two sets of powertrains and transmission systems, making its structure very complicated. The engine of the torque combined parallel hybrid electric vehicle directly drives the electric vehicle through the transmission system to form an engine driving mode. Due to the complexity of the hybrid system and the mutual coupling of parameters. Minimizing fuel consumption and minimizing emissions conflicts. Minimizing an indicator may increase the value of another indicator. The objective function of the HEV dynamic parameter optimization simulation model includes multiple sub-objective functions such as fuel consumption per 100 km and exhaust emissions, and at the same time meets the dynamic performance required by the design. One of the most critical developments of HEV is the study of the operating mode, control strategy and control logic of the powertrain [10]. In the early stage of hybrid electric vehicle design, the knowledge of vehicle dynamics is usually combined with the dynamic design index of the vehicle. The primary values of engine power, motor power, battery capacity and battery bus voltage are calculated. Under the constraints of vehicle dynamic performance, the power system and control parameters are optimized simultaneously. When the conditions set by the conditions are satisfied, the optimal parameters of power system and control strategy are output.

When the charging power requirement of hybrid electric vehicle is satisfied, when the hybrid electric vehicle is connected to the power grid in an uncontrolled way. Because it does not participate in the regulation of the power grid, even if charging at night, it may cause its charging load to coincide with the night load of residential electricity consumption. Then, the fluctuation of power load will be intensified and the peak load will appear. Figure 2 shows the charging access status of hybrid electric vehicles in a certain area within one day.

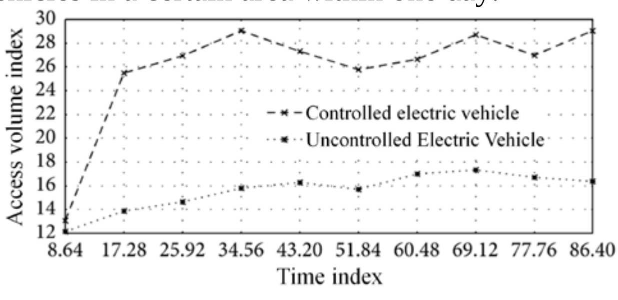

Fig.2. Hybrid vehicle charging access status

The main function of the engine drive is to enable the hybrid electric vehicle to approach or reach the level of the internal combustion engine vehicle when driving in the suburbs or at high speed. When the vehicle adopts the optimized parameters obtained under other working conditions, the final value of the battery SOC may be different after the vehicle runs the working condition. Hybrid electric vehicle engines are available in a wider range, and can be used in other types of heat engines such as gas turbines, rotary engines, and Stirling engines. The main structural feature of series hybrid power assembly is that the engine and generator constitute a generating set, and the battery, motor and generator are connected by power distribution device. Battery bus voltage increases more, so that the battery can provide more auxiliary power to the motor, so that the motor can provide more auxiliary torque to meet the needs of rapid acceleration under working conditions. On the basis of parameter optimization of hybrid electric vehicle based on single working condition, it is necessary to realize parameter optimization for multi-working condition by constructing composite working condition and changing constraints.

4. Conclusions

In order to ensure that the engine works better in the high efficiency area. In this paper, an improved logic threshold energy management strategy based on rules is proposed, which is based on the traditional logic threshold energy management strategy. The optimized parameters obtained from the parameter optimization of hybrid electric vehicle based on multi-working conditions can not only be applied to various working conditions, but also further improve the fuel economy of the vehicle. The primary battery bus voltage can meet the auxiliary power demand, and the braking recovery energy is less, so it is not necessary to increase the battery bus voltage. The dynamic system parameters of HEV horse area have significant effects on the power performance, fuel economy and emission performance of the vehicle. For HEV, the reasonable matching of the drive system parameters will directly determine whether the HEV can meet the energy conservation and environmental protection requirements. The matching problem of the hybrid electric vehicle drive system parameters must be considered in conjunction with the hybrid hybrid approach and control strategy research. In the case of a large reduction in engine power, sufficient auxiliary power can still be provided to make the vehicle meet the driving conditions. The energy management strategy can well distribute the torque of the engine and the motor, better maintain the balance of the battery SOC, and significantly improve the economic performance of the vehicle.

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