Number :143

Applied Energy Symposium
MITA+B（MITAB）
Co-organized with Harvard

Connected HEVs Energy Management Strategy Research Under the Traffic Information Preview

Yang Shichun, Feng Song, Xie Hehui, Liu Jian , Fei Chen*, Hua Yang

School of Transportation Science and Engineering, Beihang University, Beijing, China

1. Introduction

With the development of intelligent transportation system, the performance of vehicles can be further improved. Using V2V communication, vehicles can exchange information such as speed, acceleration and expected trajectory with surrounding vehicles. The intelligent transportation system can make the vehicle interact with the traffic facilities. Taking the traffic light as an example, the vehicle can obtain the future state of traffic light in advance, so as to plan the velocity trajectory and reduce the low-speed driving condition.

The traditional hybrid electric vehicle optimizes the power distribution between the engine and the motor, and reduces the fuel consumption by making the engine work in the high efficiency range. However, due to the lack of the road information, traffic information and the information of surrounding vehicles, it is hardly to plan the velocity trajectory ahead of time, thus the traditional energy optimization strategy has limitations. Taking Parallel hybrid electric vehicle as the research object, this paper studies the fuel economy optimization of parallel hybrid electric vehicle in the connected environment. The velocity trajectory of vehicle is optimized in upper controller, and the energy distribution strategies based on Rule and Genetic fuzzy algorithm are designed in the lower controller.

2. Velocity Optimization

The velocity trajectory is optimized in upper controller. The safety future velocity range can be calculated by utilizing the traffic signal phase and timing. The speed optimization function considering the energy consumption, acceleration or deceleration range and the difference with the maximum velocity is designed. The path trajectory shown in Fig.1 and the velocity trajectory shown in Fig.2 indicate the vehicle velocity in connected environment is relatively stable. The stable velocity contributes to improve the fuel economy and the ride comfort.

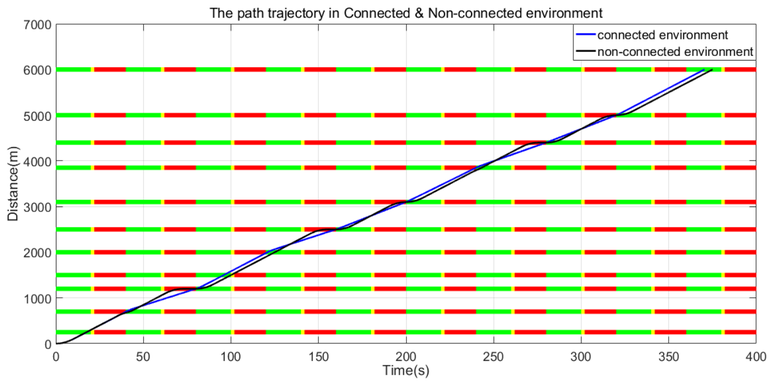

Fig 1. Vehicle path trajectory

Fig 2. Vehicle velocity trajectory

3. Energy Management Strategies

3.1 Hybrid Vehicle Model

The parallel hybrid electric vehicle shown as Fig.3 is our study object. Specially, the vehicle model in Advanced Vehicle Simulator (ADVISOR) is adopted in this paper.

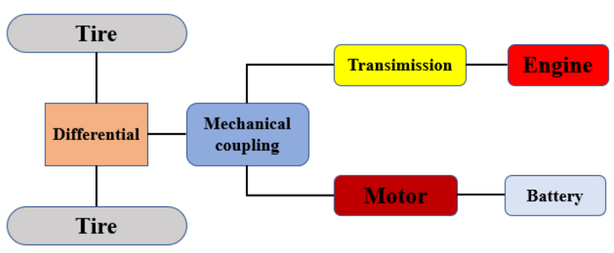

Fig 3. Hybrid electric vehicle structure

Contact email: johnfei1@126.com

3.2 Optimization Strategies Design

In this paper ,the energy management strategies based on Rule and fuzzy logic controller optimized by genetic algorithm are designed in Simulink. Shown as Fig.4, the inputs of Fuzzy controller vehicle demand torque T_req and the battery SOC value, the output of the controller is engine torque T_eng. Genetic algorithm is used to optimize the membership function of fuzzy control, and the genetic algorithm parameters are shown in Table.1.

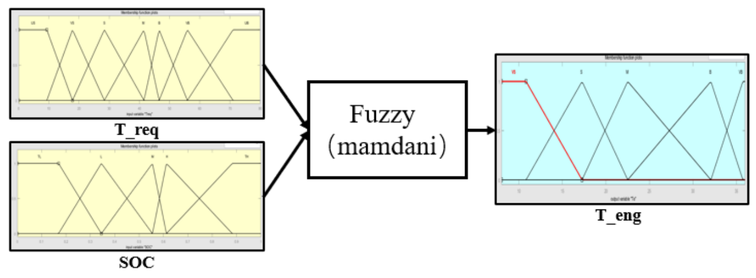

Fig 4. Fuzzy logic controller optimized by genetic algorithm

Table.1 Parameters in genetic algorithm

Population size	Length	Crossover rate	Mutation rate	Number of generations
60	85	0.7	0.01	100

4. Simulation Results and Analysis

The initial SOC value is set as 0.7, and the Fig.5 indicates the change of SOC value during driving. The emissions including the HC，CO and NOx are represented in Fig.6. Table.2 shows the comparison of simulation results.

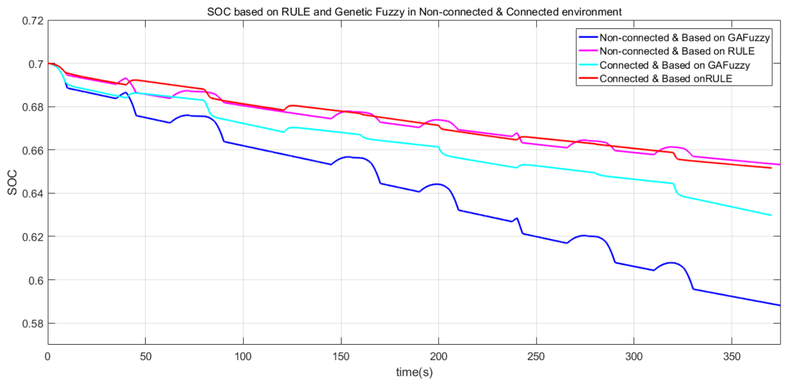

Fig 5. SOC based on Rule and Genetic fuzzy

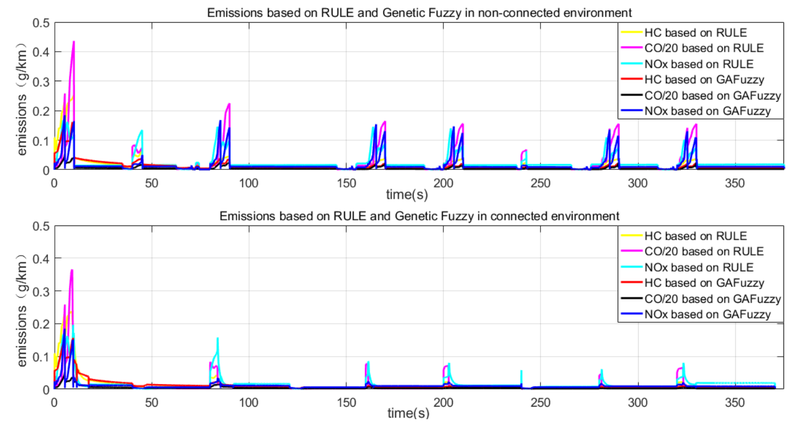

Fig 6. Emissions based on Rule and Genetic fuzzy

Table.2 Comparison of simulation results

		FC(L/100km)	HC(g/km)	CO(g/km)	NOx(g/km)	end SOC
Non-connected environment	Rule	6.5	0.592	7.876	0.463	0.6532
	Fuzzy controller based on GA	4.3	0.518	2.554	0.384	0.5881
Connected environment	Rule	4.4	0.571	5.868	0.376	0.6516
	Fuzzy controller based on GA	3.8	0.51	2.491	0.279	0.6298

The simulation results(the case with same energy management strategy and different environment) indicate that optimizing vehicle velocity trajectory in connected environment can effectively reduce fuel consumption and pollutant emission. Meanwhile, the case with same environment and different strategy demonstrate that, compared with Rule-based strategy, the Fuzzy controller optimized by Genetic algorithm contributes to realize the superior fuel economy performance and lower emissions.

With the development of intelligent transportation system facilities, optimizing vehicle driving cycle from macro perspective will further develop the performance of vehicles in the future.