Vehicle Idling Stop&Start Testing System

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Abstract: Vehicle fuel economy is poor, because the urban traffic is congested, the auto is constantly in the idle condition resulting in the increase of fuel consumption. In order to improve the vehicle fuel economy, the experimental scheme was designed through analyzing the work mechanism of automobile Idling Stop&start System (ISS). Engine working conditions were simulated by drive motor, the road resistance was simulated through electromagnetic brake controlled current to achieve the control of braking torque. The models of ISS were established, which consists of drive motor, regenerative braking, braking pedal and road resistant simulation. The test system was verified based on hardware in the loop simulation test system. The test results show that the models and the experimental scheme are rational and effective. It is a good testing and simulation platform for the further research on energy-saving mechanism and control technology.

Key words: Idling stop&start system;Testing system; Model; Hardware-in-loop simulation

Modern city caused by concentrated population and vehicles, city vehicle operation condition presents a high speed, low fuel consumption, emissions and noise characteristics, especially for the bus, because the site bus stops in urban areas, the distance between station and station is not long. According to the statistics, the average bus station is about l km, and the average length of time for each site is about 1 min. Traffic congestion in urban areas, low speed, plus traffic traffic lights, the car starts and stops very frequently. The long parking condition causes the pilot to be idle in time, not only using fuel, but also high in fuel consumption and polluting the environment. In Japan, Europe and other countries in recent years, car manufacturers have developed a new type of energy saving technology auto idle stop launch System (ISS: Idling Stop&start System), this System can make vehicle engine low emissions and improve fuel economy performance. However, in our country, the system is still in its infancy. Group by analyzing the auto idle stop start the system working principle, design the ISS of measurement and control scheme, and set up the system mathematical model, on the hardware in the loop simulation test bench has carried on the experimental analysis, for the research of auto idle stop start system energy-saving mechanism and control technology and other related theory and key technology to lay a good foundation.

1.Idle speed stop the starting system working principle

The car idling stops the system at the time of the gearshift, stops the car and automatically closes the engine. When the driver leaves the brake pedal, the engine starts again and starts the car. When the engine is restarted, the auxiliary battery system is used to supply the power. The ISS saves fuel by automatically turning off the engine when the car stops, such as a traffic jam or a red light. When the car brakes, the ISS does the braking energy recovery.

Idle stop, through the DC - DC converter, from the battery to automotive electrical equipment with CVT (CVT: ContinuouslyVariable Transmission) pump and heater with electric pump power supply. CVT oil pump can make stable when a vehicle is in idle stop CVT oil pressure, make the engine from the stopped state startup drive good smooth response and maneuverability. When the engine electronic Control sheet (ECUElectronic Control Unit) to determine vehicles are in a state of brake or slow down, to achieve energy recovery by braking energy recovery system, the motor power, system recovery of braking energy stored in the accumulator. When the engine ECU determines that the vehicle meets the starting condition, the engine starts quickly.

2.ISS measurement and control scheme design

To test the vehicle in the idle stop start running characteristics, in the cases of measurement and control experimental system is shown in figure 1, including vehicle ISS control module, the braking energy recovery control module, inertial module, road resistance simulation module, the brake pedal control module, the motor torque control module, measurement and control system module, etc.

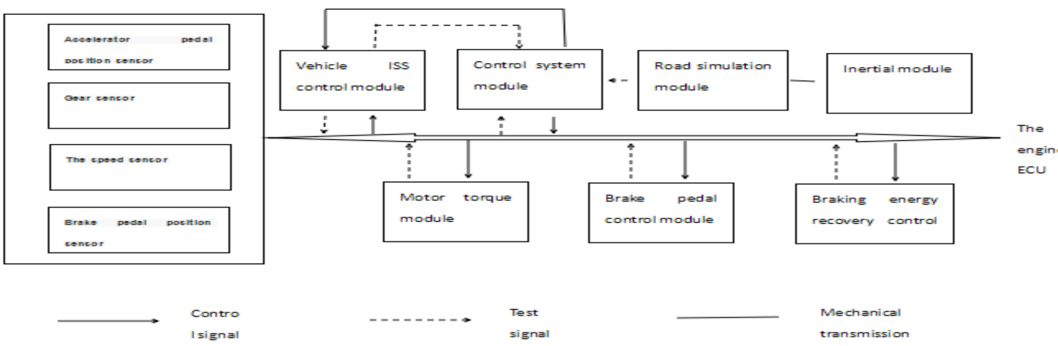

Figure 1 system test control scheme

Measurement and control system simulate test purpose is to achieve the car running condition and the operation process, for the proposed idle stop start method and control strategy of hardware in the loop simulation, in order to improve the system control methods and control strategies, to achieve the optimal control system. Therefore, the test system should be equipped with the functions of car driving condition, idle speed stop and starting performance simulation, road resistance simulation and regenerative braking energy recovery.

The system is used to simulate the speed, torque and power of the engine when the vehicle is on the road. In the braking process, the use of motor torque control module control current reverse power load motor output a reverse simulation road load torque, complete road simulation link, so as to realize the simulation of vehicle different road conditions. The inertia of the vehicle's actual road is simulated by an inertial module.

The measuring and control system module can determine the driving condition of the vehicle by collecting the speed, accelerating the position of the pedal, the position of the brake pedal and the position of the gear. When the engine ECU determines that the vehicle is braking or decelerating, cut off the fuel supply and pass the signal to the vehicle ISS control module for processing. The vehicle ISS - ECU will then pass the signal bus to the braking energy recovery control module to realize the braking energy recovery. The control signal of the control system is composed of two parts, one from the position sensor of the brake pedal. The other part is brake pedal control module, according to the brake pedal model relation with brake force and brake comfort requirements, the simulation drivers braking behavior intention and brake.

3.ISS mathematical model.

3.1 driver motor model

Electric motors are used instead of engine driven, and have strong controllability, which is good for different operating conditions. The torque and speed driving system of the motor is the same as the speed, acceleration and inertia of the vehicle during certain driving conditions.

The drive motor simulates the torque provided by the engine:

$$T_e = J_f \frac{a}{R_w} \frac{i_{eb}}{i_{ef}^2} + 4J_b \frac{av}{R_w^2 R_b} + F_R \frac{v}{R_w} \qquad (1)$$

Type: Te - drive motor torque, N. A - vehicle acceleration, m/s2; V - vehicle speed, km/h; Ieb - the total ratio of the driver motor to the electromagnetic clutch; Ief - drive motor power and the total drive ratio of the flywheel; Rw - simulate the radius of the wheel, m; FR - the total resistance on the flat surface of a vehicle. Rb-brake radius, m; Jb-brake and motor total rotational inertia, kg m2; Jf-flywheel moment of inertia, kg m2.

3.2Road resistance model

The road resistance is simulated by the electromagnetic brake, and the electromagnetic brake can control the braking torque by controlling the current of the electromagnetic brake.

$$T_{eb} = K_{et} I_{eb}^2 \omega \qquad (2)$$

Type: -electromagnetic brake torque constant; -electromagnetic brake

Electricity current, A; Omega - at certain speeds, r/min; Teb - braking moment, N dot m.

Combined with the driving equation of the car, the torque of the electromagnetic brake simulating the driving condition of the vehicle is:

$$T_{eb} = \left(\frac{1}{4} mgf + \frac{C_D A v^2}{84.56} + \frac{1}{4} mgz\alpha\right) R_w \quad (3)$$

Formula: m - vehicle weight, kg; G -- the acceleration of gravity, 9.8 m/s2; F - the coefficient of rolling resistance of vehicle tyres; A - car windward area, m2; Z - car braking strength; CD - vehicle windward resistance coefficient; Alpha-hydraulic braking ratio.

Combined (2) and (3) the electromagnetic brake control current is:

$$I_{eb} = \frac{\left(\frac{1}{4} mgf + \frac{C_D A v^2}{84.56} + \frac{1}{4} mgz\right) R_w}{K_{et}\,\omega} \quad (4)$$

The electromagnetic brake input current is controlled separately to realize the different forces of the four wheels.

3.3 brake pedal model

The system brake pedal equivalent structure is shown in figure 2:

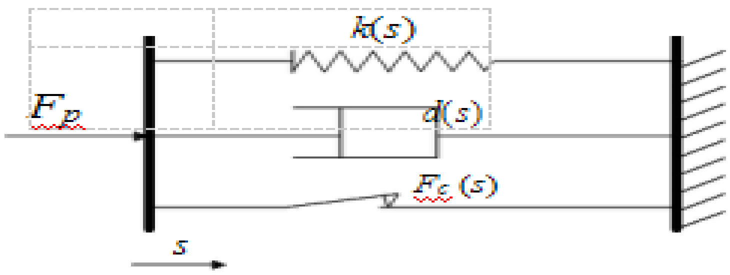

Figure 2 brake pedal equivalent physical model

The mathematical physics equation of the motor characteristic of first order nonlinear delay system:

$$F_p = k(s) \cdot s + d(s) \cdot \dot{s} + F_c(s) \quad (5)$$

Type:K (s) - the elastic coefficient of variation of the displacement of the pedal. D (s) - the damping coefficient of variation of the displacement of the pedal. Fc (s) - coulomb friction, N; S-pedal displacement, m; Fp - brake pedal force, N.

3.4 braking energy recovery model

From the vehicle theory, the motor torque is the torque of regenerative braking

$$T_m = \frac{9549 P_m}{n_m} \quad (6)$$

Type: Tm - regenerative braking motor torque, N • m; Pm - motor power, kW; Nm - motor speed, r/min.

And then you have the power on the drive wheel

$$F_w = \frac{T_m \eta_T i_g i_o}{r_d} \quad (7)$$

Type: fw-drive wheel drive, N; Eta T - transmission efficiency; Ig -- transmission ratio; IO - the main reduction gear ratio; Rd - wheel dynamic radius, m.
The relationship between speed and motor speed:

$$v = \frac{0.377 r_q n_m}{i_q i_o} \quad (8)$$

Type: rg-wheel rolling radius, m.
Formula (6) (7) (8) :

$$F_w = \frac{3600 P_m}{v} \quad (9)$$

4.ISS test analysis.

In order to verify the effectiveness of the proposed measure, the test control system was simulated on the platform of the ring simulation test.

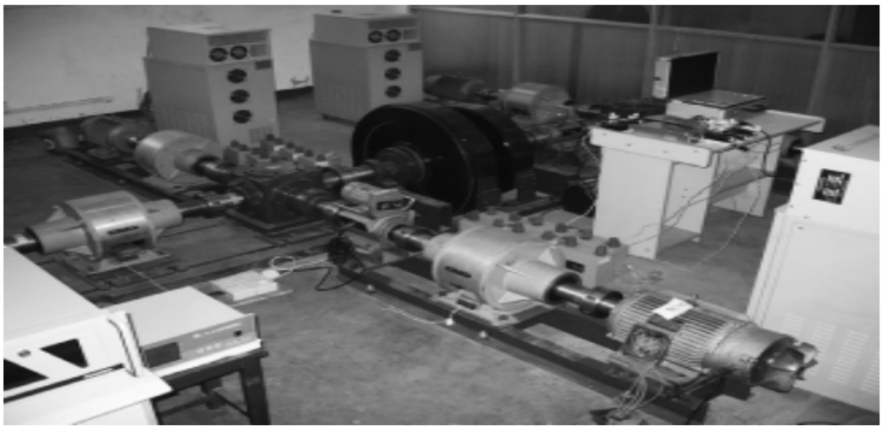

Figure 3 vehicles in the loop simulation test system

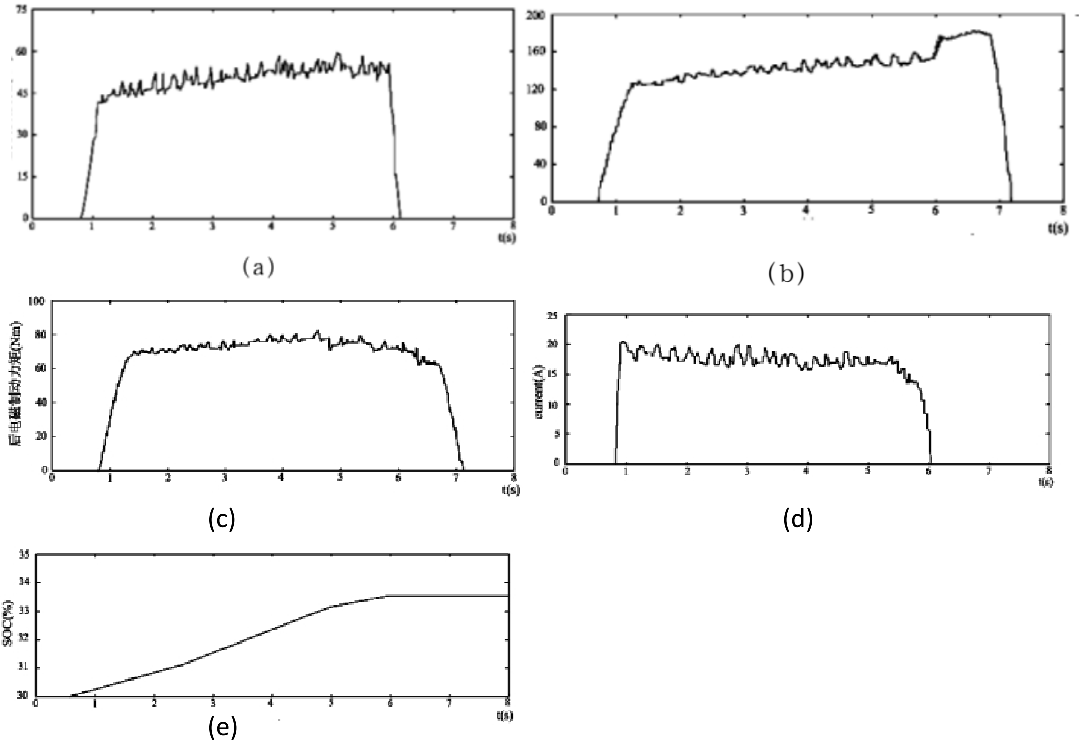

Figure 4 hardware is in the loop simulation test

Figure 4 shows the simulation test for the hardware under 80km/h of the test vehicle. Figure 4 (a) for the system change of motor braking torque motor drive module, figure 4 and figure 4 (b) (c) resistance module for system before and after the change of electromagnetic braking torque. Figure 4 (d) and figure 4 (e) are the rechargeable charging current and SOC changes for the system braking energy recovery module. From the results of the experiment, the design of the ISS measurement and control system, which has a strong controllability in the simulation test of the hardware, can meet the requirements of the measurement and control.

5 .conclusion

The car idling stop start the control system to integrate the drive motor module, road resistance simulation, brake energy recovery, brake pedal and other modules. The measurement and control process of the vehicle stop was analyzed. Based on the hardware in the loop simulation test system has carried on the preliminary verification, for using the theory of ISS measurement and control system of automobile energy saving and control method for validation and optimization provides a good platform for the test.

6.Reference

[1] meng wenlong. Study of the Hinf control method of engine idling stop system in automobile engine. [D].harbin institute of technology, 2014.
[2] yellow star. Engine rapid relaunch/stop control system mode switching analysis [J]. Automotive engineer, 2014, (2005) : 31-35.
[3] maoya. Research and development of engine control system. [D]. Wuhan institute of technology, 2013.
[4] zhang yingjian. Engine idle start stop system research and CRUISE simulation [D].hefei university of technology, 2013.
[5] Sophie, HongWei Han Liwei, Duan Wei, jay, xue-jun li. GDI engine idle stop technology without starter starting experimental study [J]. Journal of internal combustion engine, 2011, (6) : 527-533.
[6] ho ren, liu kai, wang weiwei. The passenger car with hydraulic energy storage device stop starting system [J]. Modern manufacturing engineering, 2010, (01) : 131-134.
[7] zhao qinan. The reform of the teaching of table tennis options in the college table tennis curriculum [J]. Private technology, 2008, (06) : 84-85.