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Integration mechanism for a parallel hybrid vehicle system

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Abstract

The parallel hybrid-vehicle system discussed here features two mechanisms: an internal-combustion-engine energy-distribution mechanism and dual energy-integration mechanism. The former comprises a first pulley set and a second pulley set, whereby it is possible to adjust its radius ratio and change the road surface oriented output load, output speed and required load, to maintain an optimal operating state for the internal-combustion engine at a given generator rotational speed. In this way, the engine can be maintained in an optimal state. For the dual energy-integration mechanism, any power source can be individually actuated by an electric motor and the power transmitted from the internal-combustion engine energy-distribution mechanism. Moreover, a one-way clutch can prevent the actuated power source from reversion, so any output power source will not be affected by another inactive power source. Also, the two input power-sources can be integrated into a bigger power source via a dual energy-integration mechanism, thus resulting in twice the output energy and obtaining the necessary tractive power to reach the road surface. A dynamic equation is therefore derived for this system to obtain the flow direction of the power source. Furthermore, dynamic equations of various system components can be established by modularized software Matlab/simulink and fuzzy logic are used to control and develop this system's dual energy-integration mechanism as a control strategy. After the engine's energy is distributed by the controller of the dual

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energy-integration mechanism, decelerated by the reduction ratio of the first pulley set of internal combustion engine distribution mechanism and added to the generator torque energy transmitted from second pulley set, the engine can maintain an optimum state under various operating conditions.

Keywords: Parallel hybrid vehicle; Internal-combustion engine energy-distribution mechanism; Dual energy-integration mechanism

Nomenclature and abbreviations

A	frontal projected area of vehicle (m^2)
C_d	coefficient of air friction
F	tractive force (N)
i_e	deceleration ratio of the first pulley-set
i_f	deceleration ratio of final drive
i_g	deceleration ratio of the second pulley-set
J_D	rotational inertia of internal-combustion engine's energy-distribution mechanism
J_e	rotational inertia of all components on the internal-combustion engine's axle
J_F	rotational inertia of dual energy-integration mechanism
J_g	rotational inertia of generator axle
J_w	rotational inertia of final drive
m	vehicle weight (kg)
N_d	rotational speed transmitted from the internal-combustion engine's energy-distribution mechanism to the dual energy-integration mechanism (rpm)
N_e	rotational speed of engine (rpm)
N_f	rotational speed of final drive (rpm)
N_m	rotational speed of motor (rpm)
N_w	rotational speed of tire (rpm)
P_d	power transmitted from the second pulley set of the energy-distribution mechanism to the dual energy-distribution mechanism (W)
$P_{i\text{–}f}$	power loss of the dual energy-integration mechanism (W)
P_k	output power of dual energy integration mechanism (W)
P_m	power of motor transmitted to the dual energy-distribution mechanism (W)
PSIM	a stimulation tool
R	radius of vehicle tire (m)
SOC	state of charge
T_a	torque of the first pulley set on the internal-combustion engine's axle (Nm)