Design of Power Management System for Mild Hybrid Vehicle

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This thesis presents power management control strategies for SAMAND mild hybrid vehicle with Integrated Starter Alternator (ISA) and new transmission technologies: Continuously Variable Transmission (CVT), and Automated Manual Transmission (AMT). These control strategies co ordinate the power delivery from the two power sources – battery and petroleum fuel – to the driven wheels, and transfer of the regenerative braking energy to the battery.

The proposed vehicle controller for the SAMAND mild hybrid vehicle with AMT consists of Transmission Control Unit (TCU), Energy Management Unit (EMU), and Regenerative Braking System (RBS). A gear-shifting strategy is developed for the TCU to emulate the shifting strategy of a professional driver. The driver's torque demand is estimated via a proposed driver command interpreter and is distributed between the ICE and ISA by the EMU. In the case of braking, the proposed RBS computes the mechanical and electrical braking forces required to meet driver's braking command.

Two control strategies are developed for the SAMAND mild hybrid vehicle with CVT consisting of deterministic and fuzzy rule based strategies. The included CVT Control Unit (CCU) calculates the permissible CVT ratio range. The final CVT ratio and ICE Optimal Operating Point (OOP) are computed by making a compromise between emission reduction and efficiency improvement of the ICE. The fuzzy rule based strategy first computes the OOP and then changes it according to the State of Charge (SOC) of the battery and driver's torque request values. It is in contrast to the proposed deterministic rule based strategy which first finds the ICE candidate operating points considering all the driving conditions and then computes the OOP among them; as a result, the computed ICE optimal torque can be requested directly from the ICE.

The feasibility of operation of the vehicle controllers has been demonstrated by simulating the SAMAND vehicle with normal gasoline engine (XU7JPL3) in ADVISOR. Furthermore, according to the simulation results, it is realized that the mild hybrid vehicle with CVT and 42V lead-acid battery has the fuel consumption reduction potential of about 14%. Although ADVISOR is a backward-facing simulation tool, a driver model is incorporated in the modeling system using a new method. The SAMAND conventional and μ-Hybrid vehicles with manual transmission are also modeled to be compared with mild hybrid vehicle.