Control and Optimization Approach for a Hydromechanical Hydraulic Hybrid Vehicle

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The CCEFP Hydraulic Hybrid Passenger Vehicle (HHPV) test bed is based on a hydro-mechanical transmission (HMT) power-split architecture. Compared to other hydraulic hybrid architectures, such as the parallel and series architectures, the HMT architecture has the simultaneous advantages that 1) it makes use of the efficient mechanical transmission to transmit of part of the power so that it does not rely fully on the less efficient hydraulic components; 2) it fully decouples the engine operating condition from the vehicle requirements so that full engine management can be performed; 3) it enables regeneration; 4) independent wheel torque control is possible for high performance vehicle dynamics control. The parallel and series architectures have some of these advantages but not all. Because of the ability for full engine management and the reduced dependence on hydraulics components for power transmission, it can be shown that the HMT is will be more efficient than either the series or parallel architectures for a given mean hydraulic transmission efficiency.

The HMT offers multiple degrees of freedom of operation and is thus more complex to control. Therefore, in this poster, we will discuss the design of the control and optimization of such an HMT architecture. Specifically, a three level control architecture has been developed. The high level control manages the energy storage system based on overall drive cycle demands. A dynamic programming algorithm is used for this at the moment for off-line optimization. The mid-level control determines the optimal operating condition based on current driver and vehicle demands and desired energy storage power. This is implemented based on a static optimization map. The low level control determines the engine throttle, pump/motor commands, gears and clutches etc. to achieve the desired optimal condition. Because of the changes in dynamics as the vehicle switches between modes, engine and the pump/motors need to be working closely together for smooth and precise control.

The HMT architecture has been implemented on a vehicle based on a Polaris Ranger utility vehicle chassis with a downsized engine and HMT drive-train.

Simulations and experimental results will be presented.

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