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Title: ECMS - from HEV control back to engine control

Abstract

Equivalent consumption minimization strategy is often used for the energy management of hybrid-electric vehicles. It is straight forward understandable and can be easily implemented in an engine control unit. Setting up the optimal control problem and deriving the Hamiltonian show that the equivalence factor can be interpreted as a Lagrangian multiplier. For certain cases the derivative of the Lagragian multiplier can be assumed to be zero and thus the equivalence factor is constant and optimality can be guaranteed. Applying a simple controller, a charge sustaining controller can be found easily.

The same methodology can be applied for the case of engine-out emission control of a combustion engine vehicle. A Lagragian multiplier is defined for each constrained emission component. The derived control strategy balances fuel consumption against legislated emission components if an assumption is made for the average conversion efficiency of the exhaust aftertreatment system. If the derived strategy is stored as a function of the weighting factors, the engine can be operated achieving different emissions levels according to the legislation without the need of a new calibration. The application of this methodology for diesel engine calibration will be discussed.

Finally, the control of a Formula 1 race car is considered. Again, using Pontryagins Minimum Principle, the complex hybrid powertrain of such a vehicle can be controlled according to the FIA rules achieving minimum laptime.