Resumen de Tesis Doctoral

UNIVERSITAT POLITÈCNICA DE CATALUNYA
BARCELONATECH
Escola de Doctorat

DNI/NIE/Pasaporte	Y1064759B
Nombre y apellidos	Benjamin Bader
Título de la tesis	An Energy Management Strategy for Plug-in Hybrid Electric Vehicles
Unidad estructural	MCIA - Departament d'Enginyeria Electrònica
Programa	Doctorado Ingeniería Electrónica
Códigos UNESCO	331702 · 331102 · 120709 · 120702

(Mínimo 1 y màximo 4, podéis verlos en http://doctorat.upc.edu/gestion-academica/carpeta-impresos/tesis-matricula-y-deposito/codigos-unesco)

Resumen de la tesis de 4000 caracteres máximo (si se superan los 4000 se cortará automáticamente)

This dissertation formulates a proposal for a real time capable energy management strategy (EMS) for plug-in hybrid electric vehicles. The EMS is developed to minimize vehicle fuel consumption through the utilisation of stored electric energy and high-efficiency operation of powertrain components. This objective is achieved through the development of a predictive EMS, which, in addition to fuel-efficiency, is optimized in terms of computational cost and drivability.

The requirement for an EMS in hybrid powertrain vehicles stems from the integration of two energy stores and converters in the powertrain; in the case of hybrid electric vehicles (HEV) usually a combustion engine and one or more electric machines powered by a battery. During operation of the vehicle the EMS controls power distribution between engine and electric machine. Power distribution is optimized according to the operating point dependent efficiencies of the components, energy level of the battery and trip foreknowledge.

Due to high oil prices and legislative requirements caused by the environmental impact of greenhouse emissions, fuel economy has gained importance in recent years. In addition to increased fuel economy, powertrain hybridization permits the substituton of fuel for electrical energy by implementing an external recharging option for the battery. This vehicle class, incorporating a battery rechargeable via the electrical grid, is known as a plug-in HEV (PHEV). PHEV share characteristics of both HEVs and all-electric vehicles combining several advantages of both technologies.

The rechargeable battery feature of the PHEVs makes their EMS development especially challenging. For minimal fuel consumption, the battery is discharged optimally over the whole trip length, prioritising electrical energy when driving conditions are such that its use maximises the fuel saving that can be achieved. Therefore, an EMS for a PHEV depends heavily on the availability of a priori knowledge about the trip, i.e. the knowledge of future vehicle speed and road grade. This requires the driver to indicate the route to the EMS, as in automotive navigation systems. The indication of the route in combination with GPS or Galileo based next generation navigation systems using a geographic information system (GIS) with the terrain height profile, information about road type (e.g. motorway or country road), and maximal speed allowance can be evaluated by a speed prediction algorithm including information about the driver’s behaviour for a detailed prediction of the trip. These already available navigation systems and algorithms in combination with expected future advances and the deployment of technologies such as intelligent transport systems (ITS) and vehicle-to-vehicle communication (V2V), will make more exact traffic information available to further improve prediction. Even though, errors in the prediction data have to be considered and are therefore regarded in this work.

The EMS proposed in this dissertation combines different approaches which are executed step by step. A first estimation of the energy distribution during the trip is based on a mixed integer linear program (MILP), which allows a rough estimation of the optimal energy state of the battery during the trip. This is especially important for trips with long uphill, downhill or urban phases, i.e. sections with a particularly high or lower power requirement. The results from this first optimization are then refined by a dynamic programming (DP) algorithm, which calculates the torque distribution and the gear shift pattern during the trip with a receding prediction horizon. As DP is computational quite intensive, techniques are presented to lower the computation costs. Lastly, from the optimization a rule based strategy is extracted and optimized online using a support vector machine (SVM). This step is necessary to ensure drivability and minimal fuel consumption of the vehicle also for inexact prediction data.

Lugar	Barcelona	Fecha	25.09.2013

Firma