Master Thesis Project, 2023-2024

Braking strategy of battery electric vehicles

Supervisors: Walter Lhomme (L2EP, ULille), Jean-François Brunel (LaMcube, ULille)

e-mails: walter.lhomme@univ-lille.fr, jean-francois.brunel@polytech-lille.fr

Context

In thermal vehicles, engine-based propulsion and mechanical braking are dissociated and designed separately. In new electrified vehicles, electric or hybrid, electrical machines can provide the function of traction and regenerative braking. This latter function offers the great potential to reduce the overall consumption and polluting emissions. However, the mechanical braking still leads to polluting emissions, due principally to particulate matters. Several solutions are possible to tackle these non-exhaust emissions. A first possibility is to act directly to the mechanical braking by changing the design of the brakes or/and developing new kinds of actuation system [1]. In electrified vehicles, the regenerative braking can be optimized to ensure minimum use of mechanical brakes. However, a key limitation of this optimization is to get a multi-physical modelling coupled with both electrical and mechanical subsystems. Since the scale effects of these subsystems and their study tools are different, specific research works must be carried out for an efficient and representative coupling.

Objective and Steps

This master thesis aims to develop a comprehensive modelling of the brake distribution for battery electric vehicles within the frame of the RITMEA project[1]. Several steps will be achieved to reach this objective. An energetic model will be first developed on a real battery electric vehicles, by using the instrumented Nissan Leaf of the "electricity & Vehicles" scientific platform of L2EP within the framework of the CUMIN programme[2]. Second, a tribological characterization on the mechanical brakes of the Nissan Leaf will be realized, by using the "Friction" scientific platform of LaMcube. A multi-physical modelling of the BEV by taking into account both models will be then developed. The Energetic Macroscopic Representation (EMR) will be used to organize the models [2]. At the end of the Master thesis, a multi-objective braking strategy, to take into account the battery regeneration and also the particle emissions, will be proposed and compared to the strategy implemented into the real Nissan Leaf.

Keywords

Electric vehicles, brake wear, particle emissions, regenerative braking, optimization

References

[1] G. Perricone, V. Matějka, M. Alemani, G. Valota, A. Bonfanti, A. Ciotti, U. Olofsson, A. Söderberg, J. Wahlström, Oleksii N., G. Straffelini, S. Gialanella, M. Ibrahim, "A concept for reducing PM10 emissions for car brakes by 50%", Wear, 396–397, pp. 135-145, 2018.

[2] A. Bouscayrol, J.-P. Hautier, B. Lemaire-Semail, "Graphical formalisms for the control of multi-physically energetic systems COG and EMR", Systemic design methodologies for electrical energy systems, pp. 89-124, London and Hoboken: ISTE and John Wiley & Sons, 2012.

[3] A. Bouscayrol, E. Castex, P. Delarue, A. Desreveaux, O. Ferla, J. Frotey, R. German, J. Klein, W. Lhomme, J. F. Sergent, "Campus of university with mobility based on innovation and carbon neutral", 2017 IEEE Vehicle Power and Propulsion Conference (VPPC), Belfort, France, pp. 1-5, Oct. 2017.

[1] RITMEA (Research and Innovation in Eco-responsible and Autonomous Transport and Mobility) is co-financed by European Union with the financial support of the European regional development fund and the French Region of Hauts-de-France.

[2] Launched in 2016 by the University of Lille, the CUMIN programme (Campus of University with Mobility based on Innovation and carbon Neutrality) aims to address the transition to electrified vehicles through the development of an eco-campus based on electromobility [3].