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Development of multispeed ratio drivetrains for electric vehicles

Benoit Boulet
McGill University, Canada

As the story goes, Tesla tried to develop a two-speed ratio transmission for its Roadster around 2007. But after a series of failures that delayed production and almost tanked the company, a decision was made to use a single-speed-ratio transmission. Tesla's ensued success with single-speed-ratio drivetrains, also adopted by other electric car manufacturers, leads to the question: Is there a need for multispeed drivetrains in electric vehicles? If so, for what class of vehicles? Is it economical? Our research has shown that the electrification of vehicles larger than class 3 is where multispeed transmissions may be considered, but perhaps not currently for smaller vehicles, apart for high-performance race cars or GTs. The cost question, while crucial in the automotive industry, is very difficult to settle for a new electric powertrain design because the production volumes are still very small. Given a set of performance specs for the vehicle, and assuming peak power is not the main constraint, is it better to choose a larger motor and power inverter for a single-speed-ratio architecture, or to select a smaller inverter and motor coupled to a two-speed transmission? To help resolve this question, we studied the cost-reliability-performance of EV powertrains to come up with formulas that could be used in a design optimization trading off the cost of the powertrain versus its performance and reliability. On the performance side, we designed a two-speed clutch-less automated manual transmission (AMT) and tested it on a compact electric car for dynamometer and road testing. Then, we studied friction in the synchromesh of an AMT to design a feedback controller for the synchronizer's cone clutch. This was done to control friction at a favourable location in the mixed lubrication regime on the Stribeck curve that maximizes torque transfer while minimizing wear during gear shifts. A new type of two-speed transmission was also designed to alleviate the torque dip of the AMT while avoiding the use of a clutch. The resulting patented Dual Brake Transmission (DBT) has shown promise for high efficiency, high torque and smooth operation of EVs.

Biography

Benoit Boulet is an Associate Dean (Research & Innovation) of the Faculty of Engineering at McGill University and an Associate Professor in the Department of Electrical and Computer Engineering. He has completed his Bachelor's degree from Université Laval in 1990, and Master of Engineering degree from McGill University in 1992, and a PhD degree from the University of Toronto in 1996, all in electrical engineering. He is a registered Professional Engineer in the province of Québec. He is a member of the McGill Centre for Intelligent Machines and his research areas include the design and control of electric vehicles and green energy systems, robust control of biomedical systems, and robust industrial control.

benoit.boulet@mcgill.ca

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