TOP TEN

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Multi-Objective Design Optimization Method for Electric Powertrains

Electromobility and thus electric powertrains (eDrives) are key technologies in the fight against climate change. Renewable, green energy must be used as efficiently as possible to achieve long driving ranges, which is why energy efficiency is a key design objective in the development of new eDrives. Moreover, costs and performance are crucial to convince as many people as possible to adopt electromobility. Furthermore, a compact package design is crucial for integration into the vehicle. These requirements and objectives in general represent a complex area of conflict.
In order to find the best suitable eDrive design, this research presents a computer-automated, multi-objective optimisation method. It automatically designs the complex eDrive system consisting of an electric machine, power electronics and gearbox. The result is a so-called Pareto front, containing optimal tradeoff solutions, which are tailor-made for the specific vehicle requirements. The design problem is solved by an artificial intelligence method called differential evolution, in combination with fast digital twin models. The state of the art is extended such that the eDrive system consisting of electric machine, gearbox and power electronics is optimised holistically regarding conflicting objectives of energy efficiency, costs, performance and package space. The method's effectiveness is proven by a case study including a particularly energy-efficient demonstrator vehicle. In summary, the industry-approved optimisation method leads to improved product and process quality in the design of electric powertrains. This improves customer-relevant criteria, such as driving range and costs of electric vehicles - thus contributing to widespread application of environmentally-friendly and sustainable electromobility.