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RESEARCH REPORT

Unsettled Technology Areas in Electric Propulsion Systems

Yuxiang Jiang, PhD

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Unsettled Technology Areas in Electric Propulsion Systems

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About the Editor

Dr. Yuxiang Jiang is Vice President at the Jiangsu Alternative Energy Vehicle Research Institute in Jiangsu, China. In this role, he manages the Vehicle Control and Integration Tech Center for the development and testing of electric propulsion system on electric vehicles (EVs) and oversees electric drive unit design and development.

Dr. Jiang earned his PhD in Mechanical Engineering from the University of Illinois and his MS and BS in Energy and Power Engineering from Tsinghua University. He also has an MBA from University of Michigan.

Dr. Jiang has 25 years of experience in major automotive companies, such as General Motors, Ford, and FCA in the United States and SAIC, BAIC, and Geely in China. He was previously the Director of Powertrain Integration Management at FCA Asia Pacific and has a proven record in hybrid and EV development.

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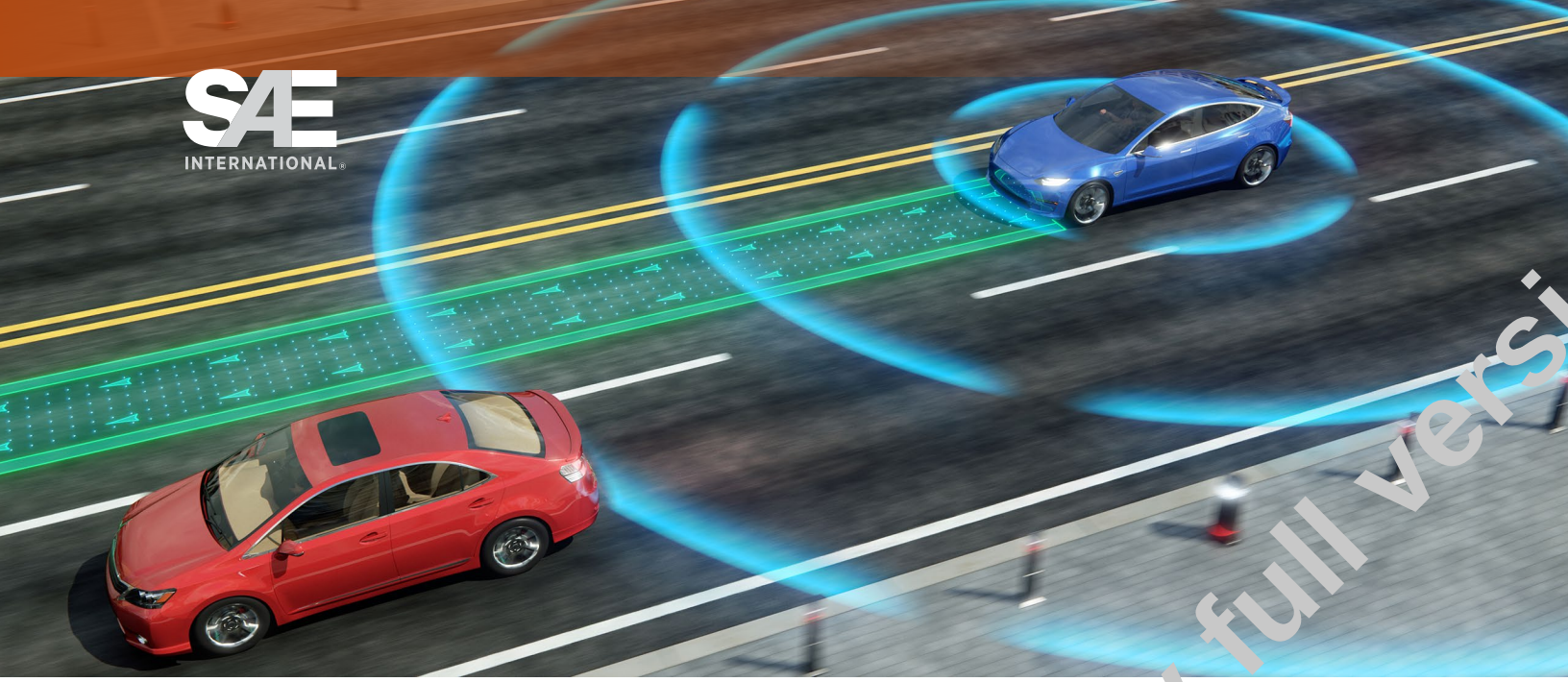

Unsettled Technology Areas in Electric Propulsion Systems

Abstract

Electric vehicle (EV) transmission technology—crucial for battery electric vehicles (BEVs) and hybrid electric vehicles (HEVs)—is developing very fast. Single-speed gearboxes are popular in electric drive systems due to their simple and cost-effective configuration. However, multispeed gearboxes are being taken to market due to their higher low-speed torque, dynamic performance, and energy efficiency.

For multispeed transmissions, the powershift function is the key to success. But the technology is not mature enough yet. It is required to operate without torque interruption during shifting, which necessitates a more complicated control algorithm.

While popular single-speed gearboxes have less mechanical loss than two-speed gearboxes, both low-speed torque and maximum vehicle speeds are expected to increase with the introduction of higher performance motors. Higher motor speeds will bring additional noise, vibration, and harshness, as well as thermal and sealing challenges.

Customers want good performance at low cost. Besides price and styling, they consider performance, shift quality, and energy consumption when purchasing a vehicle. Single-speed and multispeed gearboxes are acceptable if they can meet consumer performance expectations. From the manufacturer's side, the choice of a high-speed motor or a multispeed transmission is a trade-off between cost and performance. It is important to review the economic drivers, existing technologies, and current challenges.

The pros and cons for both single-speed and multispeed gearboxes will be discussed in this report, and numerical analysis for comparison will be presented. With the help of expert contributors, several different technical aspects are considered to develop a deeper understanding of the multispeed transmission technologies in both electric and hybrid vehicles.

NOTE: SAE EDGE Research Reports are intended to identify and illuminate key issues in emerging, but still unsettled, technologies of interest to the mobility industry. The goal of SAE EDGE Research Reports is to stimulate discussion and work in the hope of promoting and speeding resolution of identified issues. These reports are not intended to resolve the challenges they identify or close any topic to further scrutiny.

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