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Multi-physics sensor fusion for power module prognostics in xEVs

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Power electronics underpins modern xEVs allowing efficient energy transfer between the vehicle battery system and the drive motors. These vehicles have to operate in a wide range of climates and geographies meaning that the electrical systems have to be designed to withstand significant overstresses, particularly from self-heating and sudden loading during normal operation. As a result, the power electronics are significantly over-designed to ensure sufficient reliability given the harsh operating conditions. To simplify construction, reduce costs and increase reliability, manufacturers are seeking ever-tighter system integration. In the future, wide-bandgap semiconductor materials such as SiC will allow significant improvements in power density and volumetric efficiency by closely coupling the signal and power stages and allowing the power stage to be integrated within the electrical machine, sharing the same cooling circuit. This level of integration poses a number of significant challenges as the heat transfer paths are interlinked and significantly more complex. In addition, the close thermal coupling with the machine will greatly increase the stress on the electrical and mounting connections, leading to bond wire degradation and unwanted stresses in the interface layer between the semiconductor material and the substrate. To address these challenges, we propose a multi-physics sensor fusion technique to provide accurate prognostics for highly integrated power electronic converters for electric vehicles. The real-time prognostics, accurately estimating state of health and the true age of the converter, will allow the vehicle management system to intelligently adjust the available power and cooling requirements.

Biography

Kamyar Mehran obtained his BSc (Tehran, 1999); MSc (Newcastle, 2004) and PhD (Newcastle, 2010) all in Electronic and Electrical Engineering. He is currently a Lecturer in Power Engineering at Queen Mary University of London (UK). His research interests include energy storages, DC/AC microgrids, SiC-based inverters, control and energy management systems with a number of publications and book chapters in the field. He recently recieved research grants totalling £600K on condition monitoring of xEV battery modules. He has prior academic experince in the universities of Warwick and Newcastle in UK and 10 years of industrial experience including CTO position for a university spin-off.

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