**Tutorial for PESA 2020**

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**Title:** Emerging Hybrid Reluctance Motor Drives for Electric Vehicles

**Abstract:**

Traditional rare-earth PM synchronous motors have been widely adopted for electric vehicle propulsion due to high torque density and high efficiency. However, the rare-earth material is a nonrenewable source and the price is high and fluctuating with supply status. Therefore, how to reduce the rare-earth material in electric motors while maintaining the vehicle driving performance becomes an important research topic. Reluctance motors are potential solutions. This tutorial will first provide a review for the emerging reluctance motor drives for electric vehicles, including different synchronous reluctance motors, switched reluctance motors, doubly-fed doubly salient motors, variable flux reluctance motors, etc. The technology status and development trends for the existing solutions will be comparatively studied. Further, a new family of flux-modulated reluctance motors will be introduced. The proposed solution incorporates the flux modulation principle into reluctance motor designs, which contributes to improved torque density and efficiency and thus exhibit good potential for electric vehicles. The motor topologies, operation principles, electromagnetic analysis, and advanced control methods will be comprehensively presented. Finally, some prospects will be provided for future research and development of reluctance motor drives for electric vehicles.

**Short Resume**

Dr. Zhao Xing currently holds the position of research assistant professor at Department of Electrical Engineering, The Hong Kong Polytechnic University, Hong Kong SAR. His research interests involve electrical machines, motor drives and power electronics with applications to electric vehicles, renewable energy systems and robotics. Dr. Zhao received his B. Eng. degree from Nanjing University of Aeronautics and Astronautics, China, in 2014, and then obtained Ph.D. degree from The Hong Kong Polytechnic University, Hong Kong SAR, in 2020, both in Electrical Engineering. From Jul. 2019 to Jan. 2020, he was a Research Scholar with the Center for Advanced Power Systems, Florida State University, United States. Dr. Zhao is a member of IEEE, member of IEEE Societies of IES, IAS, PES & MS. He has published over 20 papers in leading journals and 3 authorized patents. He serves as a Peer Reviewer for over 10 IEEE Trans. journals and many international conferences. He was a session chair for international conference INTERMAG 2019 and a committee member for PESA 2020.