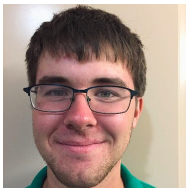
Multi-Objective Design Optimization of Electric Propulsion Drive Systems for Hybrid and Fully Electric Aircraft

SPEAKERS



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About The Speakers:

Benjamin Luckett:
Benjamin Luckett graduated from the University of Kentucky in 2020 with bachelor's degrees in Electrical and Computer Engineering. He is now pursuing his PhD in Electrical Engineering at the University of Kentucky. His research interests include the modeling and optimization of power conversion systems for transportation, and specifically aviation, applications.

JiangBiao He:
JiangBiao He is an Associate Professor in electrical engineering at the University of Kentucky, USA. He previously worked in industry, most recently as a Lead Engineer at GE Global Research, Niskayuna, New York. He also worked at Eaton Corporation and Rockwell Automation before he joined GE in 2015. He received the Ph.D. degree in electrical engineering from Marquette University, USA. His research interests include power electronics and electromagnetics for broad industry applications, particularly for transportation electrification and renewable energy systems. He has authored and co-authored over 130 technical papers and 10 U.S. patents. He is an IEEE Senior Member, and has served as an Editor or Associate Editor for several prestigious IEEE journals. He also served in various roles in the organizing committees for numerous IEEE conferences, and has been an active member of multiple IEEE standards working groups. He is the recipient of the 2019 AWS Outstanding Young Member Achievement Award recognized by the IEEE Industry Applications Society.

ABSTRACT

Driven by the global motivation to achieve zero-emission transportation, the mobility sector has been experiencing a rapid revolution of electrification. Unfortunately, the mature technologies used in the present electrification of ground vehicles and ships cannot be directly applied when tackling the distinct set of challenges posed by the working environment of an aircraft, which is characterized by high altitude, severe operating conditions, and complicated mission profiles. When designing an electric propulsion system which will be subjected to these harsh circumstances, reliability must heavily influence all decisions. But simultaneously, the drivetrain needs to be lightweight, compact, efficient, and cost effective as well. These various objectives typically prove to be impossible to satisfy concurrently, and therefore trade-offs need to be established in order to extract the highest overall system performance. The degree of importance placed upon each objective and the resulting compromises can be troublesome to explicitly quantify when designing a single system, but a Pareto front of many candidate power converters can be established without these constraints. The most optimal design for a specific application can then be chosen from this qualified set.

This tutorial focuses on multi-objective design optimization of electric propulsion drive systems for hybrid and electric aircraft. The discussed approach employs a genetic algorithm which generates many high performing designs that exhibit optimal trade-offs between competing objectives, such as reliability and specific power. Computationally efficient time-based electro-thermal simulations of multiple converter topologies, which forms the backbone of the framework, will be discussed. Also, the sizing and selection of all system elements realized though off-the-shelf components will be examined. Finally, a software package has been developed which encapsulates the described framework, and its functionality will be showcased throughout the tutorial.

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