Electrified Aerospace Propulsion and High Bandwidth Power Hardware in Loop Test Platform: Raytheon Technologies Research Center

Abstract

Hybrid and Series Turbo Electrified Aircraft architectures have their benefits with respect to fuel burn and CO2 emission reduction. However, it is extremely difficult to beat combined power density and efficiency of a traditional gas turbine engine of a single aisle aircraft (20MW class) using state of the art electric drive train technologies. This tutorial will offer an overview of the ongoing activities at the Raytheon Technologies Research Center on the design and development of electrified aerospace propulsion systems and corresponding power distribution network.

Additionally, a flexible high bandwidth (5kHz) Real-Time (RT) Power-Hardware-in-the-Loop (PHIL) platform suitable for the emulating high speed electrical drive train for hybrid electric propulsion systems will be presented. RT-PHIL capability enables rapid prototyping, evaluation and testing of both the component-level (e.g. power converters, batteries and machines) performance and system-level interaction with the rest of the aircraft electrical distribution. The commissioned PHIL system can be easily configured to emulate different subsets of the electrical network as well to study the performances of the integrated system throughout flight mission profile. The modeling approach and the PHIL platform will be described in detail and some experimental setup and test results will be discussed.

Instructor Bio

Parag Kshirsagar (S'01–M'07–SM'18) received his M.S. degree in electrical engineering from Tennessee Technological University, Cookeville, TN, USA, in 2003; and the Ph.D. degree in from Virginia Polytechnic Institute and State University (Virginia Tech), Blacksburg, VA, USA, in 2015. Since 2007, he has been with the Power Electronics Group and is the Discipline Leader with Raytheon Technologies Research Center, East Hartford, CT, USA. His research interests include power converter topologies, pulse-width modulation techniques, high-efficiency and high-speed motor drives, sensorless control algorithms, high-density electromechanical actuators, magnetic bearing systems, and electric motor design. In his current role he is responsible for advancing the electrification and sustainability technologies (which includes wide and ultra-wide band-gap devices) from the Research Center and working jointly with Raytheon Technologies' aerospace and defense businesses.

He is Senior Member of IEEE Industry Application Society – Industry Power Conversion Committee. He has chaired several sessions for IEEE Energy Conversion Congress Exposition

(ECCE) and served as panelist for Electric Propulsion for Future Aero and Space Vehicles in 2020. He is also a Member of AIAA Propulsion and Energy.

Xin Wu : received B.S degree from Huazhong University of Science and Technology, China, in 1999 and Ph.D degree from University of South Carolina, USA in 2005, all in electrical engineering. From 2005 to 2010 she worked at Ansoft Corporation as a senior research engineer. She is with United technologies Research Center (Now, Raytheon Technologies Research Center), since 2010 and is currently Sr. Research Manager in Electric and Electromagnetic Systems group at Raytheon Technologies Research Center, East Hartford CT. Her current research interests include high density power converters, electromagnetic filters, cryogenic converters, model based design and embedded control.

Suman Dwari (S'05–M'XX) Dr. Suman Dwari is currently a Team Leader, Power Electronics Systems at Raytheon Technology Research Center, focusing in power electronics, electromagnetics, electrical and electronics systems research and development. He received his Ph.D. degree from Rensselaer Polytechnic Institute and Master's Degree from Indian Institute of Technology Bombay, both in Electrical Engineering. He has been PI or Co-PI of many government research projects for DoD, ESTCP, DOE, DARPA and ARPAE to contribute in the areas of distributed power systems, sustainable energy resources, high performance power electronics systems and electrical system, Wide-band-gap device based power conversion, advanced passive components, and control of power electronics and electrical systems. Dr. Dwari is author of over 30 publications in highly reputed journal and conferences. He has over 20 US patents and many invention disclosure applications filed. His current research interests includes ultra wide-band semiconductor and power conversion, RF power, cryogenic power conversion, electrified aerospace propulsion, high voltage distribution system, high density ultra-fast high circuit breakers, ultra-high density integrated power converters, active EMI cancellation, long-range wireless power transfer, special electrical machines, fault tolerant design and control, AI and ML based power converter and electrical system design, and advanced sensing and control of power electronics systems..

Jagadeesh K. Tangudu (S'08–M'11-SM'12) received the B.E. degree from Andhra University, Visakhapatnam, India, the M.E. degree from Indian Institute of Science Bangalore, Bangalore, India, and the M.S. and Ph.D. degrees in electrical and computer engineering from University of Wisconsin-Madison, Madison. Since 2011, he has been with United Technologies Research Center (Now, Raytheon Technologies Research Center), East Hartford, CT, developing advanced electrical machines for

various RTX businesses including Wind, Elevator, Air conditioners, and Aviation applications. Prior to his doctoral thesis work, he worked with GE Global Research Center and GE Energy for four years working on large turbo generator, next-generation locomotive motors.

Jung-Muk (Michael) Choe (S'12–M'14) received the B.S., M.S., and Ph.D. degrees in electrical engineering from Konkuk University, Seoul, South Korea, in 2008, 2010, and 2014, respectively. He was a Researcher with LSIS, Seoul, and he was an embedded software design engineer at SK C&C. From 2014 to 2017, he was a Post-Doctoral Researcher with Virginia Tech, Blacksburg, VA, USA. Since 2018 he has been working as a senior research engineer at Raytheon Technologies Research Center, East Hartford CT. He is an expert in development of efficient power electronics and controls for aerospace applications. He received outstanding achievement award in 2021 from RTRC for his contribution of successful development of Mega-watt converter for electrified aircraft.

Parikshith Channegowda (S'12-M'18) received B.E degree from Visvesvaraya Technological University, India; M.Sc degree from Indian Institute of Science, India and Ph.D degree from University of Wisconsin-Madison, USA all in electrical engineering. From 2009 to 2012 he worked at Bloom Energy, India as a senior design engineer on grid connected distributed generation systems. Since 2018 he has been working as a senior research scientist at Raytheon Technologies Research Center, East Hartford CT. His current research interests include high density power converters, electromagnetic filters, cryogenic converters, model based design and embedded control. He has served as Technical Chair for the power electronics track in ITEC 2019, ITEC 2020 conferences. He is also active reviewer for ECCE, APEC and AIAA EATS conference.