ABSTRACT

Digital Twin Study of High-Power Density Power Train Based Hydrogen Fueled Electric Aircraft System

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Next generation of electric aircraft can achieve very high performance while simultaneously being energy efficient. For this to be viable with commercially available hardware, the applicable control strategies require accurate system modelling. Safety critical applications also require a system that can not only handle converter faults but also controller failure. To address these extremely complex issues, Digital Twin (DT) technology can be leveraged. This thesis lays the foundation for the DT implementation for multilevel converter-based AC motor drive systems. For the control, a Deadbeat Predictive Current Control (DPCC) algorithm was developed due to its superior performance with lower complexity for the Coreless Axial Flux Permanent Magnet (CAFPM) motor drive which offers better torque performance while offering higher energy to weight ratio compared to radial flux motors on the electric aircraft. Simulation results under different flight modes with both normal and extreme weather conditions are provided. Next, to verify the controller and move towards the process of DT implementation, real time simulations were performed. The results conclusively demonstrated the viability of the control algorithm in real time hardware simulations. For future DT implementation, a detailed guideline was provided at the end for different layers which includes the physical system, the digital system and the external intelligence layer for both bidirectional communication and optimization using data from both layers.