Ph.D. Defense

Ting Wei Chin
(Advisor: Prof. Graeme J. Kennedy)

“Multi-Physics High Resolution Topology Optimization for Aerospace Structures”

Tuesday, March 19 at 10 a.m.
Student Center Room 319

Abstract:
Advancements in multimaterial additive manufacturing have the potential to enable the creation of topology optimized structures with both shape and material tailoring. These are extremely useful in creating designs for multi-physics applications where engineering experience may be lacking. These include designing aerospace structures that are subjected to elevated temperature environment, where mechanical and thermal loads are present or designing structures for strength and avoiding low natural frequency resonance. Multi-physics analysis and multimaterial design parametrization present additional complexity and technical challenges to overcome for large-scale designs. Design and analysis using large-scale uniform meshes is computationally expensive due to the large number of degrees of freedom (DOFs).

The same mesh resolution can be created through adaptive mesh refinement such that it has fewer DOFs. However, due to the complexity in creating these adaptive meshes, especially for higher order 3D designs, they are mostly confined to 2D topology optimization. Large-scale multimaterial design through Discrete Material Optimization (DMO) also results in numerous partition of unity constraints and a multimaterial design space that has more local minima than an equivalent single material design space. This work presents new techniques for obtaining large-scale 3D multimaterial, multi-physics designs. Adaptive mesh refinement and higher order design parametrization are introduced to obtain smooth features. The multi-physics capabilities of the method are demonstration in the form of thermoelastic topology optimization. Multimaterial designs using adaptive mesh refinement as well as higher order design parametrization with steady-state thermoelastic topology optimization are presented. Novel technique to accelerate large-scale natural frequency-constrained topology optimization.

Committee:
- Prof. Graeme J. Kennedy, School of Aerospace Engineering, Georgia Tech
- Prof. Brian J. German, School of Aerospace Engineering, Georgia Tech
- Prof. Julian J. Rimoli, School of Aerospace Engineering, Georgia Tech
- Prof. Claudio V. Di Leo, School of Aerospace Engineering, Georgia Tech
- Prof. Kai A. James, Department of Aerospace Engineering, University of Illinois at Urbana-Champaign