Design of Nonlinear Mechanical Systems Using Numerical Optimization

Kai A. James
Columbia University
kai.james@columbia.edu

For over a century, numerical optimization has been used in the design of engineering structures. However, improvements in computing power and new ways of posing the optimization problem have allowed optimization to assume a more central role in the design process. Newer methods, including shape and topology optimization, have paved the way for algorithms that can automatically generate entire structural layouts and novel design concepts, with limited input from human designers. When combined with nonlinear solid mechanics, these algorithms represent a powerful tool for tackling complex design problems. This talk provides an introduction to numerical optimization within the context of mechanical design. The talk will include a discussion of the unique mathematical and computational challenges encountered when solving these design problems, including non-uniqueness and adjoint sensitivity analysis. I will also present the methodology and results from several example problems involving factors such as material damage, geometric nonlinearity, and aeroelastic coupling.

Biography

Kai James is a postdoctoral research scientist in the Department of Civil Engineering and Engineering Mechanics at Columbia University in New York City. Prior to this, he earned his PhD in aerospace engineering from the University of Toronto Institute for Aerospace Studies in 2012. His research focuses primarily on computational solid mechanics and computational design optimization with an emphasis on light-weight, energy-efficient systems. He is especially interested in developing novel algorithms that leverage high-fidelity computational models and topology optimization methods for conceptual design of complex nonlinear engineering structures. In August, 2015 Dr. James will be joining the faculty at the University of Illinois at Urbana-Champaign as an assistant professor in Department of Aerospace Engineering.