Tutorials

Tutorial 1 — Learning Topology Optimization Through Examples and Case Studies

August 18, 2019
9:00AM–4:30PM
Capistrano A, 4th Floor

Organizers

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Abstract:

The objective of this workshop is to expose the audience to cutting-edge topology optimization techniques. Strategies for posing and solving multi-load, multi-body topology optimization problems will be presented. Recent developments in integrating topology optimization and additive manufacturing will also be discussed.

Presenter Biographies:

Krishnan Suresh is the Philip and Jean Myers Professor of Mechanical Engineering at the University of Wisconsin-Madison. He received a Master's in Manufacturing Engineering from UCLA in 1992, and a Master's and Ph.D. in Mechanical Engineering from Cornell in 1994 and 1998, respectively. He later served as an Engineering Manager at Kulicke and Soffa Industries, Philadelphia from 1998 to 2002.

He has received numerous peer-reviewed grants, including the prestigious NSF Career award. His research interests include topology optimization, additive manufacturing, advanced finite element analysis, and high-performance computing. He has co-authored over 75 peer-reviewed papers, two of which have received best-paper awards from ASME. He has also authored two textbooks on applied optimization.

He is the founder of SciArt, LLC (www.sciartsoft.com), a UW-Madison spinoff that creates and supports high-performance topology optimization software solutions.

Amir M. Mirzendehdel is a Research Scientist at the Palo Alto Research Center (PARC). He earned his Ph.D. and M.Sc. degrees in Mechanical Engineering from the University of Wisconsin-Madison and his B.Sc. in Aerospace Engineering from the Amirkabir University of Technology (Tehran Polytechnic), Iran.

His research focuses on large-scale finite element analysis and topology optimization for additive manufacturing. He has co-authored the book, "A Hands-on Introduction to Topology Optimization" with Dr. Suresh, which provides a working knowledge on the field of topology optimization.

Expected Background of Participants:

The primary audience includes senior undergraduate students, graduate students, faculty, and practicing engineers. Given this wide audience, no prior background in topology optimization is assumed; a working knowledge of finite element analysis (FEA) is however helpful. The primary objectives are to introduce the readers to topology optimization terminology, discuss and illustrate various sensitivity analysis techniques (that form the backbone of any topology optimization method), and provide numerous examples and case-studies to illustrate the merits of topology optimization. While Pareto is used in this workshop to illustrate the main concepts, the attendee can later use any topology optimization software that is capable of handling the problems.

Expected Audience

The primary audience include senior undergraduate students, graduate students, faculty, and practicing engineers.

Need for the Workshop or Tutorial

Topology optimization (TO) is an exciting method for generating insightful and creative designs. The objective of this workshop is to offer a hands-on introduction to topology optimization, by juxtaposing theory with examples and casestudies. Over the past several years, additive manufacturing (AM) has emerged as a promising alternate to subtractive methods.

AM refers to a class of manufacturing processes through which parts are fabricated by material addition. The growing interest in AM stems from its ability to fabricate highly complex parts, with minimal effort. AM and TO complement each other in that organic and complex designs generated through TO can be easily manufactured through AM. Despite the obvious synergy, there are several challenges that need to be addressed before TO and AM can be seamlessly integrated. Some of these will be discussed during the workshop.

Impact:

This workshop will teach graduate students and engineers the basics of topology optimization so that they can proceed to apply and advance the technology.

Course Outline

Morning Session
- Overview of topology optimization
- Example 1: Posing and solving a simple structural optimization problem
- Example 2: Restraints and loads
- Example 3: Stress and displacement constraints
- Example 4: Design constraints
- Example 5: Multi-load problems
- Example 6: Multi-body problems
- Exercises

Afternoon Session
- Example 7: Design iterations
- Example 8: Body forces
- Example 9: Thermo-elastic topology optimization
- Case study: GE-GrabCAD design optimization
- Case study: Alcoa-GrabCAD design optimization
- Design challenge
- Topology Optimization and Additive Manufacturing: Challenges and Opportunities