

Creating Models of Truss Structures with Optimization

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Abstract

We present a method for designing truss structures, a common and complex category of buildings, using non-linear optimization. These structures are ubiquitous in the industrial world, appearing in bridges, towers, roof supports and building exoskeletons, yet are complex enough that modeling them by hand is time consuming and tedious. We represent towers as a set of rigid bars connected by pin joints, which may change location during optimization. By tracking the location of the joints as well as the strength of individual bars as our design variables, we can simultaneously optimize the geometry and the mass of structures. We present the details of our technique together with examples illustrating its use, including comparisons with real structures.

ACM Categories: I.3.5 [Computer Graphics]: Computational Geometry and Object Modeling;—Physically based modeling; I.3.6 [Computer Graphics]: Optimization;—Function programming; I.3.6 [Computer Graphics]: Optimization;—Combinatorial optimization

Keywords: Physically based modeling, truss structures, combinatorial optimization, nonlinear optimization

1 Introduction

A recurring challenge in the field of computer graphics is the creation of realistic models of complex man-made structures. The standard solution to this problem is to build these models by hand, but this approach is time consuming and, when reference images are not available, can be difficult to reconcile with a desired look and style. Our paper presents a method, based on principles in the field of structural engineering, to quickly create novel and physically realistic truss structures such as bridges and towers, using simple mathematical techniques and a minimum of user effort.

“Truss structures” is a broad category of man-made structures, including bridges (Figure 1), tower towers, towers, roof supports (Figure 1b), building exoskeletons (Figure 2), and temporary construction frameworks. Trusses share three main and distinctive basic forms that couple constraints: rod elements (bars)



Figure 1: A cantilever bridge generated by our software, compared with the Homestead bridge in Pittsburgh, Pennsylvania.

which exert only axial forces, connected consecutively with welded or bolted pins.

These structural elements are ubiquitous in the industrial world and can be extremely complex and thus difficult to model. For example, the Eiffel Tower, perhaps the most famous tower structure in the world, contains over 25,000 girders connected at over 200,000 joints (Figure 1b) and even complex structures, such as railroad bridges, typically require hundreds of thousands of complex joints. Consequently, modeling of these structures by hand can be difficult and tedious, and an automated method of generating them is desirable.

1.1 Background

Very little has been published in the graphics literature on the problem of the automatic generation of man-made structures. While significant and successful work has been done in gener-

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Creating Models Of Truss Structures With Optimization

**Jian Guo Liang,Xun Wu,Wei Jun
Yang,Wei Zhen Chen**



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Hybrid Metaheuristics in Structural Engineering Gebrail Bekdaş, Sinan Melih Nigdeli, 2023-06-15 From the start of life people used their brains to make something better in design in ordinary works Due to that metaheuristics are essential to living things and several inspirations from life have been used in the generation of new algorithms These algorithms have unique features but the usage of different features of different algorithms may give more effective optimum results in means of precision in optimum results computational effort and convergence This book is a timely book to summarize the latest developments in the optimization of structural engineering systems covering all classical approaches and new trends including hybrids metaheuristic algorithms Also artificial intelligence and machine learning methods are included to predict optimum results by skipping long optimization processes The main objective of this book is to introduce the fundamentals and current development of methods and their applications in structural engineering *Engineering and Technology Research* Mohd Mustafa Al Bakri Abdullah, Liyana Jamaludin, Muhammad Faheem Mohd Tahir, Mohd Najmuddin Mohd Hassan, 2014-10-08 Selected peer reviewed papers related to Mechanic and Materials from the 4th International Malaysia Ireland Joint Symposium on Engineering Science and Business IMiEJS 2014 June 25 26 2014 Penang Malaysia **Industry**

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Table of Contents Creating Models Of Truss Structures With Optimization

1. Understanding the eBook Creating Models Of Truss Structures With Optimization
 - The Rise of Digital Reading Creating Models Of Truss Structures With Optimization
 - Advantages of eBooks Over Traditional Books
2. Identifying Creating Models Of Truss Structures With Optimization
 - Exploring Different Genres
 - Considering Fiction vs. Non-Fiction
 - Determining Your Reading Goals
3. Choosing the Right eBook Platform
 - Popular eBook Platforms
 - Features to Look for in an Creating Models Of Truss Structures With Optimization
 - User-Friendly Interface
4. Exploring eBook Recommendations from Creating Models Of Truss Structures With Optimization
 - Personalized Recommendations
 - Creating Models Of Truss Structures With Optimization User Reviews and Ratings
 - Creating Models Of Truss Structures With Optimization and Bestseller Lists
5. Accessing Creating Models Of Truss Structures With Optimization Free and Paid eBooks
 - Creating Models Of Truss Structures With Optimization Public Domain eBooks
 - Creating Models Of Truss Structures With Optimization eBook Subscription Services
 - Creating Models Of Truss Structures With Optimization Budget-Friendly Options
6. Navigating Creating Models Of Truss Structures With Optimization eBook Formats

- ePub, PDF, MOBI, and More
 - Creating Models Of Truss Structures With Optimization Compatibility with Devices
 - Creating Models Of Truss Structures With Optimization Enhanced eBook Features
7. Enhancing Your Reading Experience
 - Adjustable Fonts and Text Sizes of Creating Models Of Truss Structures With Optimization
 - Highlighting and Note-Taking Creating Models Of Truss Structures With Optimization
 - Interactive Elements Creating Models Of Truss Structures With Optimization
 8. Staying Engaged with Creating Models Of Truss Structures With Optimization
 - Joining Online Reading Communities
 - Participating in Virtual Book Clubs
 - Following Authors and Publishers Creating Models Of Truss Structures With Optimization
 9. Balancing eBooks and Physical Books Creating Models Of Truss Structures With Optimization
 - Benefits of a Digital Library
 - Creating a Diverse Reading Collection Creating Models Of Truss Structures With Optimization
 10. Overcoming Reading Challenges
 - Dealing with Digital Eye Strain
 - Minimizing Distractions
 - Managing Screen Time
 11. Cultivating a Reading Routine Creating Models Of Truss Structures With Optimization
 - Setting Reading Goals Creating Models Of Truss Structures With Optimization
 - Carving Out Dedicated Reading Time
 12. Sourcing Reliable Information of Creating Models Of Truss Structures With Optimization
 - Fact-Checking eBook Content of Creating Models Of Truss Structures With Optimization
 - Distinguishing Credible Sources
 13. Promoting Lifelong Learning
 - Utilizing eBooks for Skill Development
 - Exploring Educational eBooks
 14. Embracing eBook Trends
 - Integration of Multimedia Elements
 - Interactive and Gamified eBooks

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