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A HAPTIC SYSTEM FOR VIRTUAL PROTOTYPING OF POLYGONAL MODELS

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ABSTRACT

Virtual prototyping attempts to replace physical models with virtual models for the purpose of design evaluation. One task a virtual prototyping environment can address is the accessibility of the components of a mechanical system. In this paper, we demonstrate a haptics-based virtual prototyping system for finding collision-free paths for moving models in complex polygonal environments. The system can handle models and environments with hundreds of thousands of triangles, and augments innate human talents at searching for collision-free paths.

INTRODUCTION

While mechanical model design increasingly relies upon computer-aided design (CAD) and sophisticated simulation programs, physical prototypes still play an important role in design evaluation. Since physical prototypes are expensive to build, and may take significant time to manufacture, virtual prototyping environments attempt to replace as much functionality of the physical prototypes as possible with a virtual prototype.

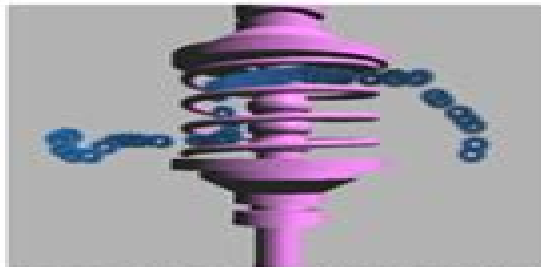


Figure 1: GUIDING A GEAR PAST A SPRING PART IN A SAMPLE VIRTUAL PROTOTYPING SESSION

Accessibility is a design evaluation task that is difficult to simulate on a computer. Two main reasons preclude easy automatic simulation:

- Computation of a collision-free path for complex models is difficult and time-consuming.
- Modeling human manipulation capabilities is difficult.

We propose a haptic system for virtual prototyping that allows human guidance and intuition in developing a collision-free path between virtual models (Figure 1). This type of system provides the intuitive usability of a physical prototype, yet retains the cost and time advantages of a computer model.

Our system has several advantages over existing haptic systems:

- Exact distances between models are computed, so the simulation is accurate to the resolution of the models.
- Haptic feedback is provided before models collide, so no invalid interpenetration of the models needs to occur.
- Models in the environment are freely movable, providing real-time adjustment to the scene as desired.

The virtual prototyping environment is demonstrated on an example mechanical system with hundreds of thousands of triangles.

BACKGROUND

Virtual prototyping of accessibility tasks is closely related to the area of path planning. The main distinction is that in virtual prototyping, there is some assumption of human involvement, whereas path planning is usually more of an automatic technique.

Path planning methods fall into two main categories – global methods and local methods. Global methods try to sample the configuration space of the model and the environment, and then connect together collision-free instances into a collision-free path[1][2][3]. Local methods use local

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Table of Contents Design Engineering Division2004 Proceedings

1. Understanding the eBook Design Engineering Division2004 Proceedings
 - The Rise of Digital Reading Design Engineering Division2004 Proceedings
 - Advantages of eBooks Over Traditional Books
2. Identifying Design Engineering Division2004 Proceedings
 - 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 Design Engineering Division2004 Proceedings
 - User-Friendly Interface

4. Exploring eBook Recommendations from Design Engineering Division2004 Proceedings
 - Personalized Recommendations
 - Design Engineering Division2004 Proceedings User Reviews and Ratings
 - Design Engineering Division2004 Proceedings and Bestseller Lists
5. Accessing Design Engineering Division2004 Proceedings Free and Paid eBooks
 - Design Engineering Division2004 Proceedings Public Domain eBooks
 - Design Engineering Division2004 Proceedings eBook Subscription Services
 - Design Engineering Division2004 Proceedings Budget-Friendly Options
6. Navigating Design Engineering Division2004 Proceedings eBook Formats
 - ePub, PDF, MOBI, and More
 - Design Engineering Division2004 Proceedings Compatibility with Devices
 - Design Engineering Division2004 Proceedings Enhanced eBook Features
7. Enhancing Your Reading Experience
 - Adjustable Fonts and Text Sizes of Design Engineering Division2004 Proceedings
 - Highlighting and Note-Taking Design Engineering Division2004 Proceedings
 - Interactive Elements Design Engineering Division2004 Proceedings
8. Staying Engaged with Design Engineering Division2004 Proceedings
 - Joining Online Reading Communities
 - Participating in Virtual Book Clubs
 - Following Authors and Publishers Design Engineering Division2004 Proceedings
9. Balancing eBooks and Physical Books Design Engineering Division2004 Proceedings
 - Benefits of a Digital Library
 - Creating a Diverse Reading Collection Design Engineering Division2004 Proceedings
10. Overcoming Reading Challenges
 - Dealing with Digital Eye Strain
 - Minimizing Distractions
 - Managing Screen Time
11. Cultivating a Reading Routine Design Engineering Division2004 Proceedings
 - Setting Reading Goals Design Engineering Division2004 Proceedings
 - Carving Out Dedicated Reading Time

12. Sourcing Reliable Information of Design Engineering Division2004 Proceedings
 - Fact-Checking eBook Content of Design Engineering Division2004 Proceedings
 - 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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