Synthesis Lectures on Computer Graphics and Animation

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Nuria Pelechano · Jan M. Allbeck · Norman I. Badler

Virtual Crowds: Methods, Simulation, and Control

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Virtual Crowds Methods Simulation And Control Norman Badler

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Virtual Crowds Nuria Pelechano,Jan M. Allbeck,Norman I. Badler,2008 There are many applications of computer animation and simulation where it is necessary to model virtual crowds of autonomous agents Some of these applications include site planning education entertainment training and human factors analysis for building evacuation Other applications include simulations of scenarios where masses of people gather flow and disperse such as transportation centers sporting events and concerts Most crowd simulations include only basic locomotive behaviors possibly coupled with a few stochastic actions Our goal in this survey is to establish a baseline of techniques and requirements for simulating large scale virtual human populations Sometimes these populations might be mutually engaged in a common activity such as evacuation from a building or area other times they may be going about their individual and personal agenda of work play leisure travel or spectator Computational methods to model one set of requirements may not mesh well with good approaches to another By including both crowd and individual goals and constraints into a comprehensive computational model we expect to simulate the visual texture and contextual behaviors of groups of seemingly sentient beings Table of Contents Introduction Crowd Simulation Methodology Survey Individual Differences in Crowds Framework HiDAC MACES CAROSA HiDAC Local Motion MACES Wayfinding with Communication and Roles CAROSA Functional Crowds Initializing a Scenario Evaluating Crowds

Virtual Crowds Nuria Palechano,Norman Badler,Jan Allbeck,2008-10-14 There are many applications of computer animation and simulation where it is necessary to model virtual crowds of autonomous agents Some of these applications include site planning education entertainment training and human factors analysis for building evacuation Other applications include simulations of scenarios where masses of people gather flow and disperse such as transportation centers sporting events and concerts Most crowd simulations include only basic locomotive behaviors possibly coupled with a few stochastic actions Our goal in this survey is to establish a baseline of techniques and requirements for simulating large scale virtual human populations Sometimes these populations might be mutually engaged in a common activity such as evacuation from a building or area other times they may be going about their individual and personal agenda of work play leisure travel or spectator Computational methods to model one set of requirements may not mesh well with good approaches to another By including both crowd and individual goals and constraints into a comprehensive computational model we expect to simulate the visual texture and contextual behaviors of groups of seemingly sentient beings Table of Contents Introduction Crowd Simulation Methodology Survey Individual Differences in Crowds Framework HiDAC MACES CAROSA HiDAC Local Motion MACES Wayfinding with Communication and Roles CAROSA Functional Crowds Initializing a Scenario Evaluating Crowds

Geometric and Discrete Path Planning for Interactive Virtual Worlds Marcelo Kallmann,Mubbasir Kapadia,2022-05-31 Path planning and navigation are indispensable components for controlling autonomous agents in interactive virtual worlds Given the growing demands on the size and complexity of modern virtual worlds a number of new

techniques have been developed for achieving intelligent navigation for the next generation of interactive multi agent simulations This book reviews the evolution of several related techniques starting from classical planning and computational geometry techniques and then gradually moving toward more advanced topics with focus on recent developments from the work of the authors The covered topics range from discrete search and geometric representations to planning under different types of constraints and harnessing the power of graphics hardware in order to address Euclidean shortest paths and discrete search for multiple agents under limited time budgets The use of planning algorithms beyond path planning is also discussed in the areas of crowd animation and whole body motion planning for virtual characters An Introduction to Verification of Visualization Techniques Tiago Etiene,Robert M. Kirby,Cláudio T. Silva,2022-06-01 As we increase our reliance on computer generated information often using it as part of our decision making process we must devise tools to assess the correctness of that information Consider for example software embedded on vehicles used for simulating aircraft performance or used in medical imaging In those cases software correctness is of paramount importance as there s little room for error Software verification is one of the tools available to attain such goals Verification is a well known and widely studied subfield of computer science and computational science and the goal is to help us increase confidence in the software implementation by verifying that the software does what it is supposed to do The goal of this book is to introduce the reader to software verification in the context of visualization In the same way we became more dependent on commercial software we have also increased our reliance on visualization software The reason is simple visualization is the lens through which users can understand complex data and as such it must be verified The explosion in our ability to amass data requires tools not only to store and analyze data but also to visualize it This book is comprised of six chapters After an introduction to the goals of the book we present a brief description of both worlds of visualization Chapter 2 and verification Chapter 3 We then proceed to illustrate the main steps of the verification pipeline for visualization algorithms We focus on two classic volume visualization techniques namely Isosurface Extraction Chapter 4 and Direct Volume Rendering Chapter 5 We explain how to verify implementations of those techniques and report the latest results in the field of verification of visualization techniques The last chapter concludes the book and highlights new research topics for the future **Sound Synthesis, Propagation, and Rendering** Shiguang Liu,Dinesh Manocha,2022-03-24 This book gives a broad overview of research on sound simulation driven by a variety of applications Vibrating objects produce sound which then propagates through a medium such as air or water before finally being heard by a listener As a crucial sensory channel sound plays a vital role in many applications There is a well established research community in acoustics that has studied the problems related to sound simulation for six decades Some of the earliest work was motivated by the design of concert halls theaters or lecture rooms with good acoustic characteristics These problems also have been investigated in other applications including noise control and sound design for urban planning building construction and automotive applications Moreover plausible or realistic sound effects can improve

the sense of presence in a virtual environment or a game In these applications sound can provide important clues such as source directionality and spatial size The book first surveys various sound synthesis methods including harmonic synthesis texture synthesis spectral analysis and physics based synthesis Next it provides an overview of sound propagation techniques including wave based methods geometric based methods and hybrid methods The book also summarizes various techniques for sound rendering Finally it surveys some recent trends including the use of machine learning methods to accelerate sound simulation and the use of sound simulation techniques for other applications such as speech recognition source localization and computer aided design *Virtual Material Acquisition and Representation for Computer Graphics* Dar'ya Guarnera,Giuseppe Claudio Guarnera,2022-05-31 This book provides beginners in computer graphics and related fields a guide to the concepts models and technologies for realistic rendering of material appearance It provides a complete and thorough overview of reflectance models and acquisition setups along with providing a selection of the available tools to explore visualize and render the reflectance data Reflectance models are under continuous development since there is still no straightforward solution for general material representations Every reflectance model is specific to a class of materials Hence each has strengths and weaknesses which the book highlights in order to help the reader choose the most suitable model for any purpose The overview of the acquisition setups will provide guidance to a reader who needs to acquire virtual materials and will help them to understand which measurement setup can be useful for a particular purpose while taking into account the performance and the expected cost derived fromthe required components The book also describes several recent open source software solutions useful for visualizing and manipulating a wide variety of reflectance models and data

Heterogeneous Spatial Data Giuseppe Patanè,Michela Spagnuolo,2022-05-31 New data acquisition techniques are emerging and are providing fast and efficient means for multidimensional spatial data collection Airborne LIDAR surveys SAR satellites stereo photogrammetry and mobile mapping systems are increasingly used for the digital reconstruction of the environment All these systems provide extremely high volumes of raw data often enriched with other sensor data e g beam intensity Improving methods to process and visually analyze this massive amount of geospatial and user generated data is crucial to increase the efficiency of organizations and to better manage societal challenges Within this context this book proposes an up to date view of computational methods and tools for spatio temporal data fusion multivariate surface generation and feature extraction along with their main applications for surface approximation and rainfall analysis The book is intended to attract interest from different fields such as computer vision computer graphics geomatics and remote sensing working on the common goal of processing 3D data To this end it presents and compares methods that process and analyze the massive amount of geospatial data in order to support better management of societal challenges through more timely and better decision making independent of a specific data modeling paradigm e g 2D vector data regular grids or 3D point clouds We also show how current research is developing from the traditional layered approach adopted by most GIS softwares to

intelligent methods for integrating existing data sets that might contain important information on a geographical area and environmental phenomenon These services combine traditional map oriented visualization with fully 3D visual decision support methods and exploit semantics oriented information e g a priori knowledge annotations segmentations when processing merging and integrating big pre existing data sets Virtual Crowds Mubbasir Kapadia,Nuria Pelechano,Jan Allbeck,Norm Badler,2015-11-01 This volume presents novel computational models for representing digital humans and their interactions with other virtual characters and meaningful environments In this context we describe efficient algorithms to animate control and author human like agents having their own set of unique capabilities personalities and desires We begin with the lowest level of footstep determination to steer agents in collision free paths Steering choices are controlled by navigation in complex environments including multi domain planning with dynamically changing situations Virtual agents are given perceptual capabilities analogous to those of real people including sound perception multi sense attention and understanding of environment semantics which affect their behavior choices The roles and impacts of individual attributes such as memory and personality are explored The animation challenges of integrating a number of simultaneous behavior and movement demands on an agent are addressed through an open source software system Finally the creation of stories and narratives with groups of agents subject to planning and environmental constraints culminates the presentation *Computer Animation and Simulation* ,1999 Crowd Simulation Daniel Thalmann,Soraia Raupp Musse,2007-09-18 Recent times have seen growing interest in crowd simulation particularly in the commercial sector where it is used in the fields of security defence entertainment and the movie industry This book focuses closely on methods and techniques for crowd simulation filling the gap in the professional literature The topics covered in this comprehensive survey include Modelling of Populations Virtual Human Animation Behavioural Animation of Crowds Crowd Rendering and Populated Environments *Simulating Heterogeneous Crowds with Interactive Behaviors* Nuria Pelechano,Jan M. Allbeck,Mubbasir Kapadia,Norman I. Badler,2016-10-26 This book provides a deep understanding of state of art methods for simulation of heterogeneous crowds in computer graphics It will cover different aspects that are necessary to achieve plausible crowd behaviors The book will be a review of the most recent literature in this field that can help professionals and graduate students interested in this field to get up to date with the latest contributions and open problems for their possible future research The chapter contributors are well known researchers and practitioners in the field and they include their latest contributions in the different topics required to achieve believable heterogeneous crowd simulation Provides crowd simulation methodology to populate virtual environments for video games or any kind of applications that requires believable multi agent behavior Presents the latest contributions on crowd simulation animation planning rendering and evaluation with detailed algorithms for implementation purposes Includes perspectives of both academic researchers and industrial practitioners with reference to open source solutions and commercial applications where appropriate **Research Centers**

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Simulating Crowds in Egress Scenarios Vinícius J. Cassol,Soraia R. Musse,Cláudio R. Jung,Norman I Badler,2017-12-08 This book describes from a computer science viewpoint the software methods of simulating and analysing crowds with a particular focus on the effects of panic in emergency situations The power of modern technology impacts on modern life in multiple ways every day A variety of scientific models and computational tools have been developed to improve human safety and comfort in built environments In particular understanding pedestrian behaviours during egress situations is of considerable importance in such contexts Moreover some places are built for large numbers of people such as train stations and airports and high volume special activities such as sporting events Simulating Crowds in Egress Scenarios discusses the use of computational crowd simulation to reproduce and evaluate egress performance in specific scenarios Several case studies are included evaluating the work and different analyses and comparisons of simulation data versus data obtained from real life experiments are given **Modeling, Simulation and Visual Analysis of Crowds** Saad Ali,Ko Nishino,Dinesh Manocha,Mubarak Shah,2013-11-22 Over the last several years there has been a growing interest in developing computational methodologies for modeling and analyzing movements and behaviors of crowds of people This interest spans several scientific areas that includes Computer Vision Computer Graphics and Pedestrian Evacuation Dynamics Despite the fact that these different scientific fields are trying to model the same physical entity i e a crowd of people research ideas have evolved independently As a result each discipline has developed techniques and perspectives that are characteristically their own The goal of this book is to provide the readers a comprehensive map towards the common goal of better analyzing and synthesizing the pedestrian movement in dense heterogeneous crowds The book is organized into different parts that consolidate various aspects of research towards this common goal namely the modeling simulation and visual analysis of crowds Through this book readers will see the common ideas and vision as well as the different challenges and techniques that will stimulate novel approaches to fully grasping crowds **A Constraint-Based Approach to Crowd Simulation and Layout Synthesis** Tomer Weiss,2018 Position based methods have become popular for real time simulation in computer graphics In contrast to traditional simulation methods which are based on Newtonian dynamics particularly forces a Position Based Dynamics PBD method computes the positional changes directly based on a set of well defined geometric constraints Therefore position based methods are reputed to be more controllable stable and faster which make them well suited for use in interactive environments This thesis introduces position based approaches to addressing the important tasks of virtual crowd simulation and virtual layout synthesis For crowd simulation we introduce a novel method that runs at interactive rates for up to hundreds of thousands of agents Our method enables the detailed modeling of per

agent behavior in a Lagrangian formulation We model short range and long range collision avoidance to simulate both sparse and dense crowds On the particles representing agents we formulate a set of positional constraints that can be readily integrated into a standard PBD solver We augment the tentative particle motions with planning velocities to determine the preferred velocities of agents and project the positions onto the constraint manifold to eliminate colliding configurations The local short range interaction is represented with collision and frictional contact between agents as in the discrete simulation of granular materials We incorporate a cohesion model for simulating collective behaviors and propose a new constraint for dealing with potential future collisions Our method is suitable for use in interactive games For layout synthesis we propose a position based interior layout synthesis method that is able to rapidly synthesize large scale layouts that were previously intractable An interior layout modeling task can be challenging for non experts hence the existence of interior design professionals Recent research into the automation of this task has yielded methods that can synthesize layouts of objects respecting aesthetic and functional constraints that are non linear and competing These methods usually adopt a purely stochastic scheme which samples from a distribution of layout configurations a process that is slow and inefficient We introduce an alternative physics based continuous layout synthesis technique which results in a significant gain in speed and is readily scalable We demonstrate our method on a diverse set of examples and show that it achieves results similar to conventional layout synthesis based on a Markov chain Monte Carlo McMC state search step but is faster by at least an order of magnitude and can handle layouts of unprecedented size and tight layouts that can overwhelm McMC *High-Level Control of Simulated Crowds* David Jacka,2011-02 The use of virtual crowds in visual e ects has grown tremendously since the war ring armies of virtual orcs and elves were seen in The Lord of the Rings These crowds are generated by agent based simulations where each agent has the ability to reason and act for itself This autonomy is e ective at automatically producing realistic complex group behaviour but leads to problems in controlling the crowds Due to interaction between crowd members the link between the behaviour of the individual and that of the whole crowd is not obvious he control of a crowd s behaviour is therefore time consuming and frustrating as manually editing the behaviour of individuals is often the only control approach available This problem of control has not been widely addressed in crowd simulation research We propose implement and test a system in which a user may control the behaviour of a crowd by means of general constraints This Constraint Satisfaction system automatically alters the behaviour of the individuals in the crowd such that the group behaviour meets the provided constraint **Crowd Dynamics, Volume 1** Livio Gibelli,Nicola Bellomo,2019-01-22 This volume explores the complex problems that arise in the modeling and simulation of crowd dynamics in order to present the state of the art of this emerging field and contribute to future research activities Experts in various areas apply their unique perspectives to specific aspects of crowd dynamics covering the topic from multiple angles These include a demonstration of how virtual reality may solve dilemmas in collecting empirical data a detailed study on pedestrian movement in smoke filled

environments a presentation of one dimensional conservation laws with point constraints on the flux a collection of new ideas on the modeling of crowd dynamics at the microscopic scale and others Applied mathematicians interested in crowd dynamics pedestrian movement traffic flow modeling urban planning and other topics will find this volume a valuable resource Additionally researchers in social psychology architecture and engineering may find this information relevant to their work **Fractional Order Crowd Dynamics** Kecai Cao,YangQuan Chen,2018-06-11 This book illustrates the application of fractional calculus in crowd dynamics via modeling and control groups of pedestrians Decision making processes conservation laws of mass momentum and micro macro models are employed to describe system dynamics while cooperative movements in micro scale and fractional diffusion in macro scale are studied to control the group of pedestrians Obtained work is included in the Intelligent Evacuation Systems that is used for modeling and to control crowds of pedestrians With practical issues considered this book is of interests to mathematicians physicists and engineers Crowd Dynamics, Volume 4 Nicola Bellomo,Livio Gibelli,2023-12-13 This contributed volume explores innovative research in the modeling simulation and control of crowd dynamics Chapter authors approach the topic from the perspectives of mathematics physics engineering and psychology providing a comprehensive overview of the work carried out in this challenging interdisciplinary research field The volume begins with an overview of analytical problems related to crowd modeling Attention is then given to the importance of considering the social and psychological factors that influence crowd behavior such as emotions communication and decision making processes in order to create reliable models Finally specific features of crowd behavior are explored including single file traffic passenger movement modeling multiple groups in crowds and the interplay between crowd dynamics and the spread of disease Crowd Dynamics Volume 4 is ideal for mathematicians engineers physicists and other researchers working in the rapidly growing field of modeling and simulation of human crowds

Introduction to Crowd Management Claudio Feliciani,Kenichiro Shimura,Katsuhiro Nishinari,2022-03-03 This book will guide you in a simple and illustrative way through all aspects related to crowd behaviour including sociological theories methods of crowd control people detection and tracking and crowd simulation and prediction while examining previous accidents to learn from the past Crowds are a constant presence in most cities around the globe and mass gatherings are attracting an increasing number of people While experience can help manage large crowds and plan mass events knowledge on crowd behaviour is fundamental for successfully dealing with unexpected situations improving current practices and implementing state of the art technologies in management strategies After letting people laugh about the controversy on colliding pedestrians with this book two of the Ig Nobel laureates on pedestrian traffic will make you think and learn presenting through a collaborative approach combining theoretical with practical advice the science behind crowd dynamics and the importance it plays in our increasingly urbanized society Fundamental aspects related to crowd management are presented using simple concepts requiring little or no knowledge of mathematics or engineering Professionals involved in

pedestrian traffic as well as students and researchers entering the field of crowd dynamics will find this book a useful interdisciplinary introduction on the subject exploring both fundamental background information and more specific topics related to crowd management

Reviewing **Virtual Crowds Methods Simulation And Control Norman Badler**: Unlocking the Spellbinding Force of Linguistics

In a fast-paced world fueled by information and interconnectivity, the spellbinding force of linguistics has acquired newfound prominence. Its capacity to evoke emotions, stimulate contemplation, and stimulate metamorphosis is really astonishing. Within the pages of "**Virtual Crowds Methods Simulation And Control Norman Badler**," an enthralling opus penned by a very acclaimed wordsmith, readers attempt an immersive expedition to unravel the intricate significance of language and its indelible imprint on our lives. Throughout this assessment, we shall delve into the book is central motifs, appraise its distinctive narrative style, and gauge its overarching influence on the minds of its readers.

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