

Jaroslav Křivánek · Pascal Gautron

Practical Global Illumination with Irradiance Caching

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Pascal Gautron

Vincent Pegoraro



Practical Global Illumination With Irradiance Caching Pascal Gautron:

Practical Global Illumination with Irradiance Caching Jaroslav Krivanek, Pascal Gautron, 2009-07-08 Irradiance caching is a ray tracing based technique for computing global illumination on diffuse surfaces Specifically it addresses the computation of indirect illumination bouncing off one diffuse object onto another The sole purpose of irradiance caching is to make this computation reasonably fast The main idea is to perform the indirect illumination sampling only at a selected set of locations in the scene store the results in a cache and reuse the cached value at other points through fast interpolation This book is for anyone interested in making a production ready implementation of irradiance caching that reliably renders artifact free images Since its invention 20 years ago the irradiance caching algorithm has been successfully used to accelerate global illumination computation in the Radiance lighting simulation system Its widespread use had to wait until computers became fast enough to consider global illumination in film production rendering Since then its use is ubiquitous Virtually all commercial and open source rendering software base the global illumination computation upon irradiance caching Although elegant and powerful the algorithm in its basic form often fails to produce artifact free mages Unfortunately practical information on implementing the algorithm is scarce The main objective of this book is to show the irradiance caching algorithm along with all the details and tricks upon which the success of its practical implementation is dependent In addition we discuss some extensions of the basic algorithm such as a GPU implementation for interactive global illumination computation and temporal caching that exploits temporal coherence to suppress flickering in animations Our goal is to show the material without being overly theoretical However the reader should have some basic understanding of rendering concepts ray tracing in particular Familiarity with global illumination is useful but not necessary to read this book

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Practical Global Illumination with Irradiance Caching Jaroslav Krivanek, Pascal Gautron, 2022-05-31 Irradiance caching is a ray tracing based technique for computing global illumination on diffuse surfaces Specifically it addresses the computation of indirect illumination bouncing off one diffuse object onto another The sole purpose of irradiance caching is to make this computation reasonably fast The main idea is to perform the indirect illumination sampling only at a selected set of locations in the scene store the results in a cache and reuse the cached value at other points through fast interpolation This book is for anyone interested in making a production ready implementation of irradiance caching that reliably renders artifact free images Since its invention 20 years ago the irradiance caching algorithm has been successfully used to accelerate global illumination computation in the Radiance lighting simulation system Its widespread use had to wait until computers became fast enough to consider global illumination in film production rendering Since then its use is ubiquitous Virtually all commercial and open source rendering software base the global

illumination computation upon irradiance caching Although elegant and powerful the algorithm in its basic form often fails to produce artifact free images Unfortunately practical information on implementing the algorithm is scarce The main objective of this book is to show the irradiance caching algorithm along with all the details and tricks upon which the success of its practical implementation is dependent In addition we discuss some extensions of the basic algorithm such as a GPU implementation for interactive global illumination computation and temporal caching that exploits temporal coherence to suppress flickering in animations Our goal is to show the material without being overly theoretical However the reader should have some basic understanding of rendering concepts ray tracing in particular Familiarity with global illumination is useful but not necessary to read this book

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Handbook of Digital Image Synthesis Vincent Pegoraro, 2016-12-12 The Handbook of Digital Image Synthesis is the most up to date reference guide in the rapidly developing field of computer graphics A wide range of topics such as applied mathematics data structures and optical perception and imaging help to provide a well rounded view of the necessary formulas for computer rendering In addition to this diverse approach the presentation of the material is substantiated by numerous figures and computer generated images From basic principles to advanced theories this book provides the reader with a strong foundation of computer formulas and rendering through a step by step process

Key Features Provides unified coverage of the broad range of fundamental topics in rendering Gives in depth treatment of the basic and advanced concepts in each topic Presents a step by step derivation of the theoretical results needed for implementation Illustrates the concepts with numerous figures and computer generated images Illustrates the core algorithms using platform independent pseudo code

Efficient Quadrature Rules for Illumination Integrals Ricardo Marques, Christian Bouville, Luís Paulo Santos, Kadi Bouatouch, 2022-06-01 Rendering photorealistic images is a costly process which can take up to several days in the case of high quality images In most cases the task of sampling the incident radiance function to evaluate the illumination integral is responsible for an important share of the computation time Therefore to reach acceptable rendering times the illumination integral must be evaluated using a limited set of samples Such a restriction raises the question of how to obtain the most accurate approximation possible with such a limited set of samples One must thus ensure that sampling produces the highest amount of information possible by carefully placing and weighting the limited set of samples Furthermore the integral evaluation should take into account not only the information brought by sampling but also possible information available prior to sampling such as the integrand smoothness This idea of sparse information and the need to fully exploit the little information available is present throughout this book The presented methods correspond to the state of the art solutions in computer graphics and take into account information which had so far been underexploited or even neglected by the previous approaches The intended audiences are

Ph D students and researchers in the field of realistic image synthesis or global illumination algorithms or any person with a solid background in graphics and numerical techniques An Introduction to Laplacian Spectral Distances and Kernels Giuseppe Patanè,2022-05-31 In geometry processing and shape analysis several applications have been addressed through the properties of the Laplacian spectral kernels and distances such as commute time biharmonic diffusion and wave distances Within this context this book is intended to provide a common background on the definition and computation of the Laplacian spectral kernels and distances for geometry processing and shape analysis To this end we define a unified representation of the isotropic and anisotropic discrete Laplacian operator on surfaces and volumes then we introduce the associated differential equations i e the harmonic equation the Laplacian eigenproblem and the heat equation Filtering the Laplacian spectrum we introduce the Laplacian spectral distances which generalize the commute time biharmonic diffusion and wave distances and their discretization in terms of the Laplacian spectrum As main applications we discuss the design of smooth functions and the Laplacian smoothing of noisy scalar functions All the reviewed numerical schemes are discussed and compared in terms of robustness approximation accuracy and computational cost thus supporting the reader in the selection of the most appropriate with respect to shape representation computational resources and target application

Virtual Crowds Mubbasir Kapadia,Nuria Pelechano,Jan Allbeck,Norm Badler,2022-05-31 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 *Numerical Methods for Linear Complementarity Problems in Physics-Based Animation* Sarah Niebe,Kenny Erleben,2022-05-31 Linear complementarity problems LCPs have for many years been used in physics based animation to model contact forces between rigid bodies in contact More recently LCPs have found their way into the realm of fluid dynamics Here LCPs are used to model boundary conditions with fluid wall contacts LCPs have also started to appear in deformable models and granular simulations There is an increasing need for numerical methods to solve the resulting LCPs with all these new applications This book provides a numerical foundation for such methods especially suited for use in computer graphics This book is mainly intended for a researcher Ph D student post doc

professor who wants to study the algorithms and do more work research in this area Programmers might have to invest some time brushing up on math skills for this we refer to Appendices A and B The reader should be familiar with linear algebra and differential calculus We provide pseudo code for all the numerical methods which should be comprehensible by any computer scientist with rudimentary programming skills The reader can find an online supplementary code repository containing Matlab implementations of many of the core methods covered in these notes as well as a few Python implementations

Erleben 2011 Table of Contents Introduction Numerical Methods Guide for Software and Selecting Methods Bibliography Authors Biographies **Mathematical Basics of Motion and Deformation in Computer Graphics** Ken Anjyo,Hiroyuki Ochiai,2014-10-22 This synthesis lecture presents an intuitive introduction to the mathematics of motion and deformation in computer graphics Starting with familiar concepts in graphics such as Euler angles quaternions and affine transformations we illustrate that a mathematical theory behind these concepts enables us to develop the techniques for efficient effective creation of computer animation This book therefore serves as a good guidepost to mathematics differential geometry and Lie theory for students of geometric modeling and animation in computer graphics Experienced developers and researchers will also benefit from this book since it gives a comprehensive overview of mathematical approaches that are particularly useful in character modeling deformation and animation Table of Contents Preface Symbols and Notations Introduction Rigid Transformation Affine Transformation Exponential and Logarithm of Matrices 2D Affine Transformation between Two Triangles Global 2D Shape Interpolation Parametrizing 3D Positive Affine Transformations Further Readings Bibliography Authors Biographies *Finite Element Method Simulation of 3D Deformable Solids* Eftychios Sifakis,Jernej Barbič,2022-06-01 This book serves as a practical guide to simulation of 3D deformable solids using the Finite Element Method FEM It reviews a number of topics related to the theory and implementation of FEM approaches measures of deformation constitutive laws of nonlinear materials tetrahedral discretizations and model reduction techniques for real time simulation Simulations of deformable solids are important in many applications in computer graphics including film special effects computer games and virtual surgery The Finite Element Method has become a popular tool in many such applications Variants of FEM catering to both offline and real time simulation have had a mature presence in computer graphics literature This book is designed for readers familiar with numerical simulation in computer graphics who would like to obtain a cohesive picture of the various FEM simulation methods available their strengths and weaknesses and their applicability in various simulation scenarios The book is also a practical implementation guide for the visual effects developer offering a lean yet adequate synopsis of the underlying mathematical theory Chapter 1 introduces the quantitative descriptions used to capture the deformation of elastic solids the concept of strain energy and discusses how force and stress result as a response to deformation Chapter 2 reviews a number of constitutive models i e analytical laws linking deformation to the resulting force that has successfully been used in various graphics oriented simulation tasks Chapter 3 summarizes how deformation

and force can be computed discretely on a tetrahedral mesh and how an implicit integrator can be structured around this discretization Finally chapter 4 presents the state of the art in model reduction techniques for real time FEM solid simulation and discusses which techniques are suitable for which applications Topics discussed in this chapter include linear modal analysis modal warping subspace simulation and domain decomposition

Information Theory Tools for Computer Graphics Mateu Sbert,Miquel Feixas,Jaume Rigau,Miguel Chover,Ivan Viola,2022-06-01 Information theory IT tools widely used in scientific fields such as engineering physics genetics neuroscience and many others are also emerging as useful transversal tools in computer graphics In this book we present the basic concepts of IT and how they have been applied to the graphics areas of radiosity adaptive ray tracing shape descriptors viewpoint selection and saliency scientific visualization and geometry simplification Some of the approaches presented such as the viewpoint techniques are now the state of the art in visualization Almost all of the techniques presented in this book have been previously published in peer reviewed conference proceedings or international journals Here we have stressed their common aspects and presented them in an unified way so the reader can clearly see which problems IT tools can help solve which specific tools to use and how to apply them A basic level of knowledge in computer graphics is required but basic concepts in IT are presented The intended audiences are both students and practitioners of the fields above and related areas in computer graphics In addition IT practitioners will learn about these applications Table of Contents Information Theory Basics Scene Complexity and Refinement Criteria for Radiosity Shape Descriptors Refinement Criteria for Ray Tracing Viewpoint Selection and Mesh Saliency View Selection in Scientific Visualization Viewpoint based Geometry Simplification

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