Curves And Surfaces For Cagd Fifth Edition A Practical Guide The Morgan Kaufmann Series In Computer Graphics

This book provides a comprehensive coverage of the fields Geometric Modeling, Computer-Aided Design, and Scientific Visualization, or Computer-Aided Geometric Design. Leading international experts have contributed, thus creating a one-of-a-kind collection of authoritative articles. There are chapters outlining basic theory in tutorial style, as well as application-oriented articles. Aspects which are covered include: Historical outline Curve and surface methods Scientific Visualization Implicit methods Reverse engineering. This book is meant to be a reference text for researchers in the field as well as an introduction to graduate students wishing to get some exposure to this subject.

The Geometry Toolbox takes a novel and particularly visual approach to teaching the basic concepts of two- and three-dimensional geometry. It explains the geometry essential for today's computer modeling, computer graphics, and animation systems. While the basic theory is completely covered, the emphasis of the book is not on abstract proofs but rather on examples and algorithms. The Geometry Toolbox is the ideal text for professionals who want to get acquainted with the latest geometric tools. The chapters on basic curves and surfaces form an ideal stepping stone into the world of graphics and modeling. It is also a unique textbook for a modern introduction to linear algebra and matrix theory.

1 Aims and Features of This Book The contents of t. his book were originally planned t. o be included in a book en titled Geometric lIIodeling and CAD/CAM to be written by M. Hosaka and F. Kimura, but since the draft. of my part of the book was finished much earlier than Kimura's, we decided to publish this part separately at first. In it, geometrically oriented basic methods and tools used for analysis and synthesis of curves and surfaces used in CAD/CAM, various expressions and manipulations of free-form surface patches and their connection, interference as well as their qualit. y eval uation are treated. They are important elements and procedures of geometric models. And construction and utilization of geometric models which include free-form surfaces are explained in the application examples, in which the meth ods and the techniques described in this book were used. In the succeeding book which Kimura is to write, advanced topics such as data structures of geometric models, non-manifold models, geometric inference as well as tolerance problems and product models, process planning and so on are to be included. Conse quently, the title of this book is changed to Modeling of Curves and Surfaces in CAD/CAM. Features of this book are the following. Though there are excellent text books in the same field such as G. Farin's Curves and Surfaces for CAD /CAM[l] and C. M.

The growing importance of animation and 3D design has caused computer-aided geometric design (CAGD) to be of interest to a wide audience of programmers and designers. This interactive software/book tutorial teaches fundamental CAGD concepts and discusses the growing number of applications in such areas as geological modeling, molecular modeling, commercial advertising, and animation. Using interactive examples and animations to illustrate the mathematical concepts, this hands-on multimedia tutorial enables users without a substantial mathematical background to quickly gain intuition about CAGD. Interactive Curves and Surfaces guides you in Learning the uses of CAGD as it is applied in computer graphics and engineering. Creating curved lines and surfaces using Bezier curves, B-Splines, and parametric surface patches. Understanding the mathematical tools behind the generation of these objects, and the development of computer-based CAGD algorithms. Experimenting with powerful interactive test benches to explore the behavior and characteristics of the most popular CAGD curves. Application oriented readers will find this animated tutorial presentation more accessible than the standard formal texts on the subject.

Implicit objects have gained increasing importance in geometric modeling, visualisation, animation, and computer graphics, because their geometric properties provide a good alternative to traditional parametric objects. This book presents the mathematics, computational methods and data structures, as well as the algorithms needed to render implicit curves and surfaces, and shows how implicit objects can easily describe smooth, intricate, and articulatable shapes, and hence why they are being increasingly used in graphical applications. Divided into two parts, the first introduces the mathematics of implicit curves and surfaces, as well as the data structures suited to store their sampled or discrete approximations, and the second deals with different computational methods for sampling implicit curves and surfaces, with particular reference to how these are applied to functions in 2D and 3D spaces.

Shape interrogation is the process of extraction of information from a geometric model. It is a fundamental component of Computer Aided Design and Manufacturing (CAD/CAM) systems. This book provides a bridge between the areas geometric modeling and solid modeling. Apart from the differential geometry topics covered, the entire book is based on the unifying concept of recasting all shape interrogation problems to the solution of a nonlinear system. It provides the mathematical fundamentals as well as algorithms for various shape interrogation methods including nonlinear polynomial solvers, intersection problems, differential geometry of intersection curves, distance functions, curve and surface interrogation, umbilics and lines of curvature, and geodesics.

Requires only a basic knowledge of mathematics and is geared toward the general educated specialists. Includes a gallery of color images and Mathematica code listings.

"Curves and Surfaces in Geometric Modeling: Theory and Algorithms offers a theoretically unifying understanding of polynomial curves and surfaces as well as an effective approach to implementation that you can apply to your own work as a graduate student, scientist, or practitioner." "The focus here is on blossoming - the process of converting a polynomial to its polar form - as a natural, purely geometric explanation of the behavior of curves and surfaces. This insight is important for more than just its theoretical elegance - the author demonstrates the value of blossoming as a practical algorithmic tool for generating and manipulating curves and surfaces that meet many different criteria. You'll learn to use this and other related techniques drawn from affine geometry for computing and adjusting control points, deriving the continuity conditions for splines, creating subdivision surfaces, and more." "It will be an essential acquisition for readers in many different areas, including computer graphics and animation, robotics, virtual reality, geometric modeling and design, medical imaging, computer vision, and motion planning."--BOOK JACKET.Title Summary field provided by Blackwell North America, Inc. All Rights Reserved

Abstract: "We review the role of implicit algebraic curves and surfaces in computer-aided geometric design, and discuss its possible evolution. Implicit curves and surfaces offer certain strengths that complement the strength of parametric curves and surfaces. After reviewing basic facts from algebraic geometry, we explore the problems of converting between implicit and parametric forms. While conversion from parametric to implicit form is always possible in principle, a number of practical problems have forced the field to explore alternatives. We review some of these alternatives, based on two fundamental ideas.

New approaches in knot insertion and deletion to understanding, analyzing, and rendering B-spline curves and surfaces.

Linear algebra is growing in importance. 3D entertainment, animations in movies and video games are developed using linear algebra. Animated characters are generated using equations straight out of this book. Linear algebra is used to extract knowledge from the massive amounts of data generated from modern technology. The Fourth Edition of this popular text introduces linear algebra in a comprehensive, geometric, and algorithmic way. The authors start with the

fundamentals in 2D and 3D, then move on to higher dimensions, expanding on the fundamentals and introducing new topics, which are necessary for many real-life applications and the development of abstract thought. Applications are introduced to motivate topics. The subtitle, A Geometry Toolbox, hints at the book's geometric approach, which is supported by many sketches and figures. Furthermore, the book covers applications of triangles, polygons, conics, and curves. Examples demonstrate each topic in action. This practical approach to a linear algebra course, whether through classroom instruction or self-study, is unique to this book. New to the Fourth Edition: Ten new application sections. A new section on change of basis. This concept now appears in several places. Chapters 14-16 on higher dimensions are notably revised. A deeper look at polynomials in the gallery of spaces. Introduces the QR decomposition and its relevance to least squares. Similarity and diagonalization are given more attention, as are eigenfunctions. A longer thread on least squares, running from orthogonal projections to a solution via SVD and the pseudoinverse. More applications for PCA have been added. More examples, exercises, and more on the kernel and general linear spaces. A list of applications has been added in Appendix A. The book gives instructors the option of tailoring the course for the primary interests of their students: mathematics, engineering, science, computer graphics, and geometric modeling.
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Putting the G into CAGD, the authors provide a much-needed practical and basic introduction to computer-aided geometric design. This book will help readers understand and use the elements of computer-aided geometric design, curves and surfaces, without the mathematical baggage that is necessary only for more advanced work. Though only minimal background in mathematics is needed to understand the bookís concepts, the book covers an amazing array of topics such as Bezier and B-spline curves and their corresponding surfaces, subdivision surfaces, and NURBS (Non-Uniform Rational B-Splines). Also included are techniques such as interpolation and least squares methods.

Non-Uniform Rational B-Splines have become the de facto standard in CAD/CAM and computer graphics. This well-known book covers NURBS from their geometric beginnings to their industrial applications. The second edition incorporates new results and a chapter on Pythagorean curves, a development that shows promise in applications such as NC machining

Computer Aided Geometric Design covers the proceedings of the First International Conference on Computer Aided Geometric Design, held at the University of Utah on March 18-21, 1974. This book is composed of 15 chapters and starts with reviews of the properties of surface patch equation and the use of computers in geometrical design. The next chapters deal with the principles of smooth interpolation over triangles and without twist constraints, as well as the graphical representation of surfaces over triangles and rectangles. These topics are followed by discussions of the B-spline curves and surfaces; mathematical and practical possibilities of UNISURF; nonlinear splines; and some piecewise polynomial alternatives to splines under tension. Other chapters explore the smooth parametric surfaces, the space curve as a folded edge, and the interactive computer graphics application of the parametric bi-cubic surface to engineering design problems. The final chapters look into the three-dimensional human-machine communication and a class of local interpolating splines. This book will prove useful to design engineers.

Focusing on the manipulation and representation of geometrical objects, this book explores the application of geometry to computer graphics and computer-aided design (CAD). Over 300 exercises are included, some new to this edition, and many of which encourage the reader to implement the techniques and algorithms discussed through the use of a computer package with graphing and computer algebra capabilities. A dedicated website also offers further resources and useful links.

Until recently B-spline curves and surfaces (NURBS) were principally of interest to the computer aided design community, where they have become the standard for curve and surface description. Today we are seeing expanded use of NURBS in modeling objects for the visual arts, including the film and entertainment industries, art, and sculpture. NURBS are now also being used for modeling scenes for virtual reality applications. These applications are expected to increase. Consequently, it is quite appropriate for The.N'URBS Book to be part of the Monographs in Visual Communication Series. B-spline curves and surfaces have been an enduring element throughout my pro fessional life. The first edition of Mathematical Elements for Computer Graphics, published in 1972, was the first computer aided design/interactive computer graph ics textbook to contain material on B-splines. That material was obtained through the good graces of Bill Gordon and Louie Knapp while they were at Syracuse University. A paper of mine, presented during the Summer of 1977 at a Society of Naval Architects and Marine Engineers meeting on computer aided ship surface design, was arguably the first to examine the use of B-spline curves for ship design. For many, B-splines, rational B-splines, and NURBS have been a bit mysterious.

NURBS (Non-uniform Rational B-Splines) are the computer graphics industry standard for curve and surface description. They are now incorporated into all standard computer-aided design and drafting programs (for instance, Autocad). They are also extensively used in all aspects of computer graphics including much of the modeling used for special effects in film and animation, consumer products, robot control, and automobile and aircraft design. So, the topic is particularly important at this time because NURBS are really at the peak of interest as applied to computer graphics and CAD of all kind.

By virtue of their special algebraic structures, Pythagorean-hodograph (PH) curves offer unique advantages for computer-aided design and manufacturing, robotics, motion control, path planning, computer graphics, animation, and related fields. This book offers a comprehensive and self-contained treatment of the mathematical theory of PH curves, including algorithms for their construction and examples of their practical applications. It emphasizes the interplay of ideas from algebra and geometry and their historical origins and includes many figures, worked examples, and detailed algorithm descriptions.

This volume presents the proceedings of COMPUTER GRAPHICS INTERNATIONAL '93 (COl '93), the Eleventh International Conference of the Computer Graphics Society (CGS), COl '93 has been held in Lausanne, Switzerland from June 21-25,1993 under the theme Communicating with Virtual Worlds. Since its foundation in 1983, COl conference has continued to attract high qUality research articles in all aspects of computer graphics and its applications. Previous conferences in this series were held in Japan (1983-1987), in Switzerland (1988), in the United Kingdom (1989), in Singapore (1990), in the United States (1991), and in Japan (1992). Future CG International conferences are planned in Australia (1994), and in the United Kingdom (1995). COS also organizes each year Computer Animation in Geneva, an international workshop and Computer Generated Film Festival. Two new CGS events are planned in 1993: Pacific Graphics '93 in Seoul and MMM '93, an International Conference on Multi-Media MOdeling in Singapore.

This collection of ideas and results on topics of curve and surface design is intended for research in the academic environment as well as for practical use in industrial applications. Main emphasis is on minimal energy splines and geometric spline curves, and on techniques beyond tensor product surfaces.

B-splines are fundamental to approximation and data fitting, geometric modeling, automated manufacturing, computer graphics, and numerical simulation. With an emphasis on key results and methods that are most widely used in practice, this textbook provides a unified introduction to the basic components of B-spline theory: approximation methods (mathematics), modeling techniques (engineering), and geometric algorithms (computer science). A supplemental Web site will provide a collection of problems, some with solutions, slides for use in lectures, and programs with demos.

The aim of the book is to provide a good foundation of Computer-Aided Geometric Design to students who are doing under-graduate courses in engineering, especially Mechanical Engineering, Computer Science, Geometric Modeling and CAD/CAM. This book is organized in two parts. Part-I deals with the basics of differential geometry of curves and surface, a good understanding of which is essential prerequisite to what follows in the Part-II. Part-II is devoted entirely to the geometric designs of curves and surfaces, which are used in the development of computer graphics and profiles and hulls of ships, aircraft wings, satellites (to name a few large scale products) as also telephones, mobile phones, fancy flower vases (to name a few small-scale products). Concepts introduced are illustrated with examples, which are completely worked out. A list of problems is also given at the end of each chapter

Ideal as a comprehensive introduction to fundamental algorithms for basic curves and surfaces, or for a deeper understanding of entities with which readers may be familiar, this book presents a simple approach to the entire structure of algorithms.

Computational Geometry: Curve and Surface Modeling provides information pertinent to the fundamental aspects of computational geometry. This book discusses the geometric properties of parametric polynomial curves by using the theory of affine invariants for algebraic curves. Organized into eight chapters, this book begins with an overview of the objects studies in computational geometry, namely surfaces and curves. This text then explores the developments in the theory and application of spline functions, which began with cubic spline functions. Other chapters consider the mechanical background of the cubic spline functions, which is the wooden spline with small deflection. This book discusses as well that in mathematical lofting the information of a geometric shape is given by a set of data points, while in geometric design other ways of representations are available. The final chapter deals with the concepts in the theory of algebraic curves. This book is a valuable resource for mathematicians.

As an introduction to fundamental geometric concepts and tools needed for solving problems of a geometric nature using a computer, this book fills the gap between standard geometry books, which are primarily theoretical, and applied books on computer graphics, computer vision, or robotics that do not cover the underlying geometric concepts in detail. Gallier offers an introduction to affine, projective, computational, and Euclidean geometry, basics of differential geometry and Lie groups, and explores many of the practical applications of geometry. Some of these include computer vision, efficient communication, error correcting codes, cryptography, motion interpolation, and robot kinematics. This comprehensive text covers most of the geometric background needed for conducting research in computer graphics, geometric modeling, computer vision, and robotics and as such will be of interest to a wide audience including computer scientists, mathematicians, and engineers.

This book provides a solid and uniform derivation of the various properties Bezier and B-spline representations have, and shows the beauty of the underlying rich mathematical structure. The book focuses on the core concepts of Computer Aided Geometric Design and provides a clear and illustrative presentation of the basic principles, as well as a treatment of advanced material including multivariate splines, some subdivision techniques and constructions of free form surfaces with arbitrary smoothness. The text is beautifully illustrated with many excellent figures to emphasize the geometric constructive approach of this book.

Curves and Surfaces provides information pertinent to the fundamental aspects of approximation theory with emphasis on approximation of images, surface compression, wavelets, and tomography. This book covers a variety of topics, including error estimates for multiquadratic interpolation, spline manifolds, and vector spline approximation. Organized into 77 chapters, this book begins with an overview of the method, based on a local Taylor expansion of the final curve, for computing the parameter values. This text then presents a vector approximation based on general spline function theory. Other chapters consider a nonparametric technique for estimating under random censorship the amplitude of a change point in change point hazard models. This book discusses as well the algorithm for ray tracing rational parametric surfaces based on inversion and implicitization. The final chapter deals with the results concerning the norm of the interpolation operator and error estimates for a square domain. This book is a valuable resource for mathematicians.

This fifth edition has been fully updated to cover the many advances made in CAGD and curve and surface theory since 1997, when the fourth edition appeared. Material has been restructured into theory and applications chapters. The theory material has been streamlined using the blossoming approach; the applications material includes least squares techniques in addition to the traditional interpolation methods. In all other respects, it is, thankfully, the same. This means you get the informal, friendly style and unique approach that has made Curves and Surfaces for CAGD: A Practical Guide a true classic. The book's unified treatment of all significant methods of curve and surface design is heavily focused on the movement from theory to application. The author provides complete C implementations of many of the theories he discusses, ranging from the traditional to the leading-edge. You'll gain a deep, practical understanding of their advantages, disadvantages, and interrelationships, and in the process you'll see why this book has emerged as a proven resource for thousands of other professionals and academics. * Provides authoritative and accessible information for those working with or developing computer-aided geometric design applications. * Covers all significant CAGD curve and surface design techniques-from the traditional to the experimental. * Includes a new chapter on recursive subdivision and triangular meshes. * Presents topical programming exercises useful to professionals and students alike. * Offers complete C implementations of many of the book's examples via a companion Web site.

As the field of computer graphics develops, techniques for modeling complex curves and surfaces are increasingly important. A major technique is the use of parametric splines in which a curve is defined by piecing together a succession of curve segments, and surfaces are defined by stitching together a mosaic of surface patches. An Introduction to Splines for Use in Computer Graphics and Geometric Modeling discusses the use of splines from the point of view of the computer scientist. Assuming only a background in beginning calculus, the authors present the material using many examples and illustrations with the goal of building the reader's intuition. Based on courses given at the University of California, Berkeley, and the University of Waterloo, as well as numerous ACM Siggraph tutorials, the book includes the most recent advances in computer-aided geometric modeling and design to make spline modeling techniques generally accessible to the computer graphics and geometric modeling communities.

The mathematical foundation of free form surface representations and constructions is an emerging field covering many interesting research problems and numerous important applications. This book contains selected presentations from the CAGD Conference at Oberwolfach, with new developments of mathematical methods and efficient algorithms for the representation of curves and surfaces. The contributions focus on the following topics: rational splines, scattered data interpolation, multivariate splines, interpolating with geometric constraints, algorithms for graphic representations.

Publisher Description

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The authors define fairness mathematically, demonstrate how newly developed curve and surface schemes guarantee fairness, and assist the user in identifying and removing shape aberrations in a surface model without destroying the principal shape characteristics of the model. A valuable resource for engineers working in CAD, CAM, or computer-aided engineering.

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This fifth edition has been fully updated to cover the many advances made in CAGD and curve and surface theory since 1997, when the fourth edition appeared. Material has been restructured into theory and applications chapters. The theory material has been streamlined using the blossoming approach; the applications material includes least squares techniques in addition to the traditional interpolation methods. In all other respects, it is, thankfully, the same. This means you get the informal, friendly style and unique approach that has made Curves and Surfaces for CAGD: A Practical Guide a true classic. The book's unified treatment of all significant methods of curve and surface design is heavily focused on the movement from theory to application. The author provides complete C implementations of many of the theories he discusses, ranging from the traditional to the leading-edge. You'll gain a deep, practical understanding of their advantages, disadvantages, and interrelationships, and in the process you'll see why this book has emerged as a proven resource for thousands of other professionals and academics. Provides authoritative and accessible information for those working with or developing computer-aided geometric design applications. Covers all significant CAGD curve and surface design techniques-from the traditional to the experimental. Includes a new chapter on recursive subdivision and triangular meshes. Presents topical programming exercises useful to professionals and students alike.

This book covers combinatorial data structures and algorithms, algebraic issues in geometric computing, approximation of curves and surfaces, and computational topology. Each chapter fully details and provides a tutorial introduction to important concepts and results. The focus is on methods which are both well founded mathematically and efficient in practice. Coverage includes references to open source software and discussion of potential applications of the presented techniques.

Assembled here is a collection of articles presented at a NATO ADVANCED STU DY INSTITUTE held at Puerto de la Cruz, Tenerife, Spain during the period of July 10th to 21st, 1989. In addition to the editors of these proceedings Professor Larry L. Schumaker from Vanderbilt University, Nashville, Tennessee, served as a member of the international organizing committee. The contents of the contribu tions fall within the heading of COMPUTATION OF CURVES AND SURFACES and therefore address mathematical and computational issues pertaining to the dis play, modeling, interrogation and representation of complex geometrical objects in various scientific and technical environments. As is the intent of the NATO ASI program the meeting was two weeks in length and the body of the scientific activities was organized around prominent experts. Each of them presented lectures on his current research activity. We were fortunate to have sixteen distinguished invited speakers representing nine NATO countries: W. Bohm (Federal Republic of Germany), C. de Boor (USA), C.K. Chui (USA), W. Dahmen (Federal Republic of Germany), F. Fontanella (Italy), M. Gasca (Spain), R. Goldman (Canada), T.N.T. Goodman (UK), J.A. Gregory (UK), C. Hoffman (USA), J. Hoschek (Federal Republic of Germany), A. Le Mehaute (France), T. Lyche (Norway), C.A. Micchelli (USA), 1.1. Schumaker (USA), C. Traas (The Netherlands). The audience consisted of both young researchers as well as established scientists from twelve NATO countries and several non-NATO countries.