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Preface

Aim of the Book

The main idea of this book is to show how small formulas like geometric DNAs can be used for constituting complex shapes and motions, and how even a common personal computer can be used for solving advanced 3D computer graphics, shape modeling, and web visualization problems.

The book provides foundations of computer graphics theory, hardware and programming, as well as outlines how computer graphics problems can be solved in major application areas. Each foundation chapter of the book offers exercises and quizzes with model solutions. The theoretical concepts are illustrated with very useful programming exercises. The book offers case studies of the commonly available graphics software—POV-Ray, OpenGL, GLUT, VRML and X3D—which will let the readers apply theoretical principles into practice without requesting expensive hardware and software solutions. Supplementary reading and sources of information on computer graphics and its applications are provided as well.

The book may serve as a text for the introductory one-semester course on computer graphics and as a reference on computer graphics, shape modeling and web visualization for graphics professionals. No prior familiarity with computer graphics is expected from the reader, but the reader should have some background in programming and data structures, as well as in analytic geometry, linear algebra and vector analysis.

Organization of the Book

The book consists of 3 parts: Basics of Computer Graphics, Advanced Computer Graphics and Programming Computer Graphics.

The first part of the book consists of 7 chapters. Chapter 1 introduces the subject of computer graphics and briefly outlines its history and application areas. Chapter 2 explains how the graphics pipeline works, and how a geometric point turns into a color spot on the computer screen. Chapter 3 introduces mathematical foundations of shape modeling, which will then be reused and reinforced in other chapters. Geometric transformation of two-dimensional shapes and basic viewing transformation are explained in Chapter 4, while Chapters 5 and 6 deal with three-dimensional geometric and projection transformations. Chapter 7 concludes the first part of the book by demonstrating how the shapes, defined mathematically, can be eventually rendered on the computer screen, and how a photorealistic appearance of them can be achieved.

The second part of the book, consisting of 4 chapters, illustrates how the foundations obtained in the first part can be used when working in several important areas of computer graphics. Chapter 8 shows how computer animation works and how mathematical formulas, defining 2D and 3D shapes, can easily be extended to time-dependent models defining moving shapes. More realism is added to moving geometric shapes by introducing physically based models. Chapter 9 explains how large virtual environments can be rendered with a real-time response. Chapter 10 considers an area which every computer engineer will be involved one way or another—how to design and build interactive programs with graphical-user interfaces. Finally, Chapter 11 puts it all together into virtual reality systems discussing their design and implementation issues, both technical and physiological.

The theoretical concepts introduced in the first two parts of the book are revisited in the last part, which consists of 4 chapters. This part of the book introduces to the reader three commonly available software tools. Chapter 12 gives a smooth start to the computer graphics novice by exercising with POV-Ray—freeware open source ray tracing software. Readers will learn how to create and render complex 3D scenes consisting of basic geometric shapes as well as sophisticated shapes defined with mathematical functions. We will also learn how to create stereo images and view them with the naked eye as well as with stereo anaglyph glasses. Software libraries OpenGL and GLUT, introduced in Chapter 13, will be used for rendering parametrically defined surfaces and their morphing transformations from one into another. Also, in this chapter an interactive shape modeling program will be studied. This program interactively ray traces shapes defined with implicit functions. The ways of extending this program to virtual embossing and carving will also be discussed. In Chapter 14 we learn about cyberworlds and 3D web visualization tools such as Virtual Reality Modeling

Language (VRML) and extensible 3D (X3D). We will study the ways how Autodesk 3ds Max can be used for making interactive VRML scenes. Also, the readers will learn how web visualization can be greatly improved with using the function-based extension of VRML and X3D, which allow for defining geometric shapes and their appearances with analytical functions. Finally, Chapter 15 will give the reader sources of further information on the topics discussed in the book, including the Book's Companion Web Page.

This book is a revised and amended edition of the book "Computer graphics: from a small formula to cyberworlds" which was printed in 2005-2011.

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