

现代计算机教育系列教材（英文版）——国外著名大学教授鼎力之作

丛书主编 金兰

Computer Graphics with OpenGL

计 算 机 图 形 学

Zhigang Xiang

（美）项志钢 编著

清华大学出版社

Tsinghua University Press



Computer graphics is an important and fascinating field of computer science. It generates graphs and images by computational means, with broad application in such areas as computer-human interaction, computer-aided design, scientific visualization, and digital arts and entertainment. This book constitutes a systematic introduction to the fundamental concepts, mathematical tools, algorithms, and techniques of computer graphics, coupled with a parallel presentation of the widely-used multi-platform application programming interface – OpenGL. Although it is written primarily for undergraduate and graduate students in computer science/computer engineering/computer application who take computer graphics as an elective, anyone with a basic understanding of analytical geometry and some working knowledge of data structures and algorithms should be able to follow along with the discussion without much difficulty.

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内 容 简 介

计算机图形学是计算机科学中一个趣味性很强的重要领域。它使用计算方法产生图形与图像,在人机信息交流,计算机辅助设计,科学及统计数据形象化,以及数字化艺术创作等许多方面有广泛应用。本书系统阐述计算机图形学的基本概念,数学工具,算法及技术,并对可用于多种平台的图形学应用程序设计界面 OpenGL 作了详细介绍。本书主要为选修计算机图形学的计算机科学、计算机工程、计算机应用专业大学生或研究生所用,也可供学习了一到两学期高等数学和计算机程序设计基础的其他专业特别是理工专业学生及有同等经验的人士阅读。

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前言

图形与图像不仅是人与人,而且是人与计算机进行信息交流的一种有效手段。一个设计得当的图形化用户界面可以在很大程度上简化计算机的使用。一幅在计算机模拟的灯光环境下产生的曲线或曲面的图像比一组代表曲线或曲面的抽象的代数方程更能激发观察者的形象思维。

计算机图形学探讨用计算方法产生图形与图像信息的理论和实现方式,包括建立几何结构模型、控制物体形状与位置、模拟光学现象以及人机交互技术和应用程序设计。

本教材对计算机图形学的基本概念、数学工具、算法及技术作系统讲述,并对可用于多种平台的图形学应用程序设计界面 OpenGL 作了详细介绍。书中材料足以为选修计算机图形学的计算机科学、计算机工程、计算机应用专业大学生或研究生一学期学习所用。也可帮助实际工作中的应用程序设计员详细了解 OpenGL。

为降低印刷成本,文中彩色插图均以黑白方式复制。其中十几幅有必要用颜色表现的原图则集中于附录后的彩色插页内。

能为清华大学出版社写作此书是件非常荣幸的事。在此特别向对鼓励我担此重任的苏伯珙教授,热心审阅原始方案及最终书稿的金兰教授以及责任编辑谢琛女士致谢。并衷心希望本书能为对计算机图形与图像生成有浓厚兴趣的读者提供有用的资料。

作 者

2005 年 10 月于美国纽约

About the Author

Zhigang Xiang is currently Associate Professor and Deputy Chair of Computer Science at Queens College of the City University of New York (CUNY). He also chairs the Computer Science Department Curriculum Committee, and is on the Doctoral Faculty of Computer Science at the CUNY Graduate School and University Center. His primary research interests and publications are in the areas of computer graphics, image processing, and interactive techniques. He received a Bachelor of Science degree in Computer Science in 1982 from Beijing Polytechnic University; a Master of Science degree in 1984 and a Ph. D. degree in 1988, both in Computer Science, from the State University of New York at Buffalo.

出版说明

为了使我国计算机的教育水平赶上国际步伐,缩小与世界计算机技术水平的差距,清华大学出版社隆重推出《现代计算机教育系列教材(英文版)——国外著名大学教授鼎力之作》。

这套教材由我国著名计算机专家金兰教授主编。金兰教授 1949 年毕业于清华大学电机系,后留校任教,1952 年赴前苏联留学,获副博士学位。1956 年回国后,金兰教授主持清华大学计算机专业的创建工作,先后担任计算机教研室主任和副系主任。1984 年后,金兰教授在美国从事计算机专业教育工作,目前是美国 Fresno 加州大学计算机科学系终身教授。

本套教材的作者均是目前在美等计算机发展水平较高的国家担任大学教授的专家学者,他们在世界各知名大学担任主讲教授,并且,他们也将在自己任教的学校使用这些教材。我们希望这套教材的出版能使我国的计算机教育尽快与世界计算机教育接轨。英文教材的编写将尽量考虑中国国情,使之适合中国学生学习。在出版英文教材的同时,还将组织与之相应的中文翻译版教材的出版,使那些学习中文版教材的学生也能赶上国际计算机教学的水平。

我们尝试用这种聘请国外教授编著教材的方法出版教材,旨在希望这套教材能够加速我国计算机教育水平的发展,缩小与发达国家的差距。同时,也能提高我国计算机教材的出版水平,为我国计算机教材注入更新的活力。希望这套教材能够得到我国计算机教育领域的广大师生的关注,并提供宝贵的建议。

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2003 年 8 月

作者介绍

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C Contents

Chapter 1	Introduction	1
Chapter 2	Digital Image Fundamentals	5
2.1	The RGB and CMY Color Models	6
2.2	Color Representation	8
2.3	Lookup Table	9
2.4	Display Devices	11
2.4.1	Color Monitor	13
2.4.2	LCD—Liquid Crystal Display	14
2.5	Printing Devices	15
2.5.1	Halftoning	15
2.5.2	Halftone Approximation	16
2.5.3	Dithering	17
2.5.4	Error Diffusion	18
2.6	Image Files	19
Chapter 3	The OpenGL API	23
3.1	OpenGL Basics	24
3.1.1	OpenGL as a State Machine	24
3.1.2	The Graphics Pipeline Concept	25
3.1.3	Event-Driven Programming	26
3.1.4	Language Binding	26

3.2	OpenGL Syntax and Convention	26
3.3	Setting up OpenGL on a PC	28
3.4	A Sample Program	28
3.5	Visualizing the Mandelbrot and Julia Sets	33
3.6	The Color-Index Mode	39
3.7	Managing Windows	40

Chapter 4 Scan Conversion 42

4.1	Lines	43
4.1.1	Direct Use of the Line Equation	43
4.1.2	The DDA Algorithm	44
4.1.3	Bresenham's Line Algorithm	44
4.2	Circles	47
4.2.1	Bresenham's Circle Algorithm	48
4.2.2	Midpoint Circle Algorithm	50
4.2.3	Arbitrarily-Centered Circles	51
4.3	Ellipses	52
4.3.1	Midpoint Ellipse Algorithm	52
4.3.2	Arbitrarily-Centered and Rotated Ellipses	55
4.4	Region Filling	56
4.4.1	Defining Regions	56
4.4.2	Boundary-Fill	57
4.4.3	Flood-Fill	58
4.4.4	A Scan-Line Method	58
4.5	Characters	61
4.5.1	Bitmap Font	61
4.5.2	Outline Font	62
4.6	Antialiasing	63
4.6.1	Pre-filtering and Post-filtering	64
4.6.1.1	Area Sampling	65
4.6.1.2	Super Sampling	66
4.6.1.3	Lowpass Filtering	66

4.6.2	Pixel Phasing	67
4.7	OpenGL Programming	67
4.7.1	Line-Based Primitives	67
4.7.2	Polygonal Primitives	68
4.7.3	Changing and Enabling Features	69
4.7.3.1	Stippled Lines	70
4.7.3.2	Fill-Style and Orientation of Polygons	70
4.7.3.3	Non-convex Polygons	71
4.7.4	Bitmap and Stroke Characters	72
4.7.5	Blending and Antialiasing	73
4.7.6	Recursively Defined Drawings	76
4.7.6.1	The C-Curve	76
4.7.6.2	Koch Curve	78
4.7.6.3	The Sierpinski Gasket	79

Chapter 5 3D Preliminaries 83

5.1	The Polygon-Mesh Representation	83
5.2	Hidden-Surface Removal	86
5.2.1	Back-Face Removal	86
5.2.2	The Z-Buffer Method	87
5.3	Projection	88
5.3.1	Taxonomy of Projection	89
5.3.2	Parallel Projection	89
5.3.3	Perspective Projection	91
5.4	The 3D Graphics Pipeline	94
5.5	OpenGL Programming	96
5.5.1	Normal Vectors	96
5.5.2	Culling	97
5.5.3	Z-Buffering	97
5.5.4	Orthographic and Perspective Projections	97
5.5.5	Double Buffer Animation	99

Chapter 6 Transformations	105
6.1 Basic Transformations	105
6.1.1 Translation	106
6.1.2 Scaling	108
6.1.3 Rotation	110
6.2 Special Transformations	114
6.2.1 Reflection	114
6.2.2 Shearing	116
6.3 Composite Transformation Matrix	117
6.4 OpenGL Programming	119
6.4.1 Modeling Transformation	119
6.4.2 The Matrix Stacks	120
 Chapter 7 Color and Shading Models	 125
7.1 Light and Color	125
7.1.1 Basic Characteristics of Light	126
7.1.2 The Trichromatic Generalization Theory	127
7.1.3 CIE XYZ Color Model	128
7.1.4 CIE Chromaticity Diagram	129
7.1.5 Color Gamut Mapping	130
7.1.6 The NTSC YIQ Color Model	131
7.2 The Phong Model	131
7.3 Interpolative Shading Methods	134
7.3.1 Constant Shading	134
7.3.2 Gouraud Shading	135
7.3.3 Phong Shading	137
7.4 OpenGL Programming	137
7.4.1 Defining Material Properties	137
7.4.2 Creating Light Sources	138
7.4.3 Controlling Light Position and Direction	140

7.4.4	Selecting Lighting and Shading Options	141
7.4.4.1	Lighting Options	141
7.4.4.2	Shading Options	142
7.4.5	Enabling Lighting	144
7.4.6	Visualizing GLUT Objects	144
Chapter 8 Viewing and Clipping		150
8.1	Viewing Transformation	150
8.1.1	Transformation to Viewing Coordinates	151
8.1.2	Normalization Transformation	152
8.1.3	Window to Viewport Mapping	157
8.2	Clipping Algorithms	158
8.2.1	Point Clipping	158
8.2.2	Line Clipping	159
8.2.2.1	The Cohen-Sutherland Algorithm	159
8.2.2.2	The Liang-Barsky Algorithm	162
8.2.2.3	Clipping Against an Arbitrary Plane	166
8.2.3	Polygon Clipping	167
8.2.3.1	The Sutherland-Hodgman Algorithm	167
8.2.3.2	The Weiler-Atherton Algorithm	169
8.3	OpenGL Programming	171
8.3.1	Viewing Transformation	171
8.3.2	Additional Clipping Planes	174
8.3.3	Terrain Generation	175
8.3.3.1	Midpoint Displacement	175
8.3.3.2	Brownian Distribution of Disks	176
Chapter 9 Interaction		182
9.1	Interactive Devices	183
9.1.1	Physical Devices	183
9.1.2	Logical Devices	184

9.2	Interactive Techniques	185
9.3	OpenGL Programming	188
9.3.1	Keyboard Functions	188
9.3.2	Mouse Functions	189
9.3.3	Menus	192
9.3.4	Editing Polygons	193
9.3.5	Creating Revolving Objects	196
Chapter 10	Parametric Representations	207
10.1	Interpolation Methods for Splines	210
10.1.1	The Natural Cubic Spline	210
10.1.2	Hermite Interpolation	212
10.1.3	Managing Tangent Vectors	213
10.1.3.1	Catmull-Rom Splines	213
10.1.3.2	Cardinal Splines	214
10.1.3.3	Kochanek-Bartels Splines	214
10.2	Bézier Curves and Surfaces	215
10.2.1	Bézier Curves	215
10.2.2	Bézier Surfaces	218
10.3	B-Splines	219
10.3.1	Uniform B-Splines	220
10.3.2	Open B-Splines	224
10.3.3	Nonuniform B-Splines	225
10.3.4	Multiple Control Points	225
10.3.5	B-Spline Surfaces	226
10.4	Rational B-Splines and NURBS	226
10.5	OpenGL Programming	228
10.5.1	Bézier Curves	228
10.5.2	Bézier Surfaces	229
10.5.3	B-Spline Functions	231

Chapter 11	More on OpenGL	236
11.1	Error Handling	236
11.2	Query Functions	237
11.3	Bitmaps and Pixel Operations	239
11.3.1	Bitmaps	239
11.3.2	Reading and Writing Pixels	240
11.3.3	Logical Operations	241
11.4	GLU Quadrics	242
11.5	Texture Mapping	244
11.5.1	Concept and Formulation	245
11.5.2	OpenGL Implementation	246
11.5.3	Texture Coordinates for Parametric Surfaces	252
11.6	Depth Cuing	252
11.7	Stencil Buffer	253
11.8	Accumulation Buffer	256
Chapter 12	Beyond the Graphics Pipeline	260
12.1	Ray Tracing	260
12.1.1	The Pinhole Camera	261
12.1.2	A Recursive Ray-Tracer	261
12.1.3	Parametric Vector Representation of a Ray	264
12.1.4	Ray-Surface Intersection	265
12.1.4.1	Coordinate System Planes	265
12.1.4.2	Arbitrary Planes	266
12.1.4.3	Spheres	267
12.1.4.4	General Implicit Surfaces	268
12.1.5	Techniques for Improving Efficiency	269
12.1.5.1	Adaptive Depth Control	270
12.1.5.2	Bounding Volume Extension	270
12.1.5.3	Spatial Subdivision	271

12.1.6	Antialiasing	272
12.1.7	Procedurally Defined Solid Texture	272
12.1.8	Additional Visual Effects	275
12.2	The Radiosity Method	277
12.2.1	Basic Formulation	277
12.2.2	Form Factors	278
12.2.3	Progressive Refinement	279
12.3	The Rendering Equation	280
 Appendix 1 OpenGL Functions		285
Appendix 2 Vectors		291
Appendix 3 Matrices		296
Appendix 4 Answers		301
Index		351

Chapter 1

Introduction

Computer graphics is one of several areas of computer science that deal with the art of visual information processing. More specifically, it investigates the theories and techniques for the creation of visual information using computers. This task is also referred to as *image synthesis*.

An image, much like an ordinary photograph, is the vehicle that carries visual information. However, unlike an ordinary photograph that records a particular view of the physical world, an image generated on a computer is merely the result of numerical computation.

This computational task consists of two main components: *modeling* and *rendering*. Modeling refers to the numerical and procedural representation of the characteristics of the objects that are necessary for the objects to be visualized, including their geometry (e. g. , a triangle may be encoded in the form of the coordinates of its three vertices and a sphere may be described by its equation) and their interaction with light (e. g. , a red sphere is visible only because it reflects red light into the viewer's eyes). On the other hand, rendering refers to the creation of images that depict the represented objects under specific viewing conditions (e. g. , the front view of a desk illuminated with a spot light at the ten o'clock position between the desk and the viewer).

There are two closely-related areas of computer science that also deal with the art of visual information processing: *image processing* and *computer vision*. The former focuses on the manipulation of visual information, whereas the later the interpretation of visual information.