

# Contents

## Preface

## Acknowledgements

<b>1. An Introduction to Computer Graphics</b>	1
1.1 The beginnings of computer graphics	1
1.2 What is computer graphics?	2
1.3 Computer graphics and biology	2
1.4 The elements of a computer graphics system	3
1.5 Computer graphics in perspective	8
1.6 References	11
<b>2. Graphics Hardware</b>	12
2.1 An overview	12
2.2 Input devices	12
2.3 Display devices	16
2.4 Display processors	27
2.5 The computer	29
2.6 References and bibliography	30
<b>3. Graphics Software</b>	32
3.1 Connecting computers and graphic devices	32
3.2 Graphics software packages	34
3.3 Graphics packages on mini computers and mainframe computers	35
3.4 Microcomputer graphics software	44
3.5 Graphics workstations	47
3.6 The applications program	50
3.7 References and bibliography	51
<b>4. Two-dimensional Graphics</b>	52
4.1 The elements of two-dimensional transformations	52
4.2 Representation of points	53
4.3 Straight line transformations	58
4.4 Rotation	60
4.5 Reflection	62
4.6 Multi-operation transformations (composition)	64
4.7 Two-dimensional homogeneous coordinates	64
4.8 Two-dimensional rotation about an arbitrary axis	67
4.9 References	70

<b>5. Three-dimensional Graphics</b>	71		
5.1 Basic concepts	71	9.3 Analysis of periodic images	145
5.2 Three-dimensional homogeneous coordinates	73	9.4 The Joyce-Loebl Magiscan	147
5.3 Three-dimensional scaling	74	9.5 Reconstruction from X-ray data	150
5.4 Three-dimensional shearing	74	9.6 References and bibliography	153
5.5 Three-dimensional rotations	75		
5.6 Reflection in three dimensions	76		
5.7 Three-dimensional translation	77	<b>10. Molecular Graphics</b>	155
5.8 Three-dimensional rotation about an arbitrary axis	77	10.1 An introduction to molecular graphics	155
5.9 Projections	82	10.2 Components of a molecular graphics system	156
5.10 Conclusions	84	10.3 Molecular data	157
5.11 References	84	10.4 Examples of molecular graphics packages	160
<b>6. Hidden Lines and Hidden Surfaces</b>	85	10.5 Some existing systems	171
6.1 An introduction to hidden lines and surfaces	85	10.6 References and bibliography	172
6.2 A simple hidden lines algorithm	86		
6.3 The Galimberti and Montanari algorithm	87	<b>11. Simulation and Animation</b>	176
6.4 The hidden surface problem	89	11.1 Moving pictures	176
6.5 A preliminary classification	90	11.2 Hardware for real-time animations	177
6.6 Surface representation and hidden surface methods	90	11.3 Concepts of graphic animation	178
6.7 Conclusions	92	11.4 Dynamic graph construction	179
6.8 References and bibliography	93	11.5 Simulation of cell division and cell interaction processes	181
<b>7. Graphical Representation of Biological Data</b>	94	11.6 Animation of genetic events	191
7.1 Introduction	94	11.7 References and bibliography	194
7.2 Graphs and histograms	94		
7.3 Point plots and transforms	99	<b>Appendix 1: Matrix Manipulations</b>	196
7.4 Graphics data structures	102	A1.1 Basic definitions	196
7.5 A data structure for hidden lines treatment	111	A1.2 Vectors	198
7.6 References	114	A1.3 Matrix addition	199
<b>8. Reconstruction Methods for Cell Systems</b>	115	A1.4 The trace of a matrix	199
8.1 Tissue reconstruction	115	A1.5 The determinants of a matrix	200
8.2 The role of computer graphics	115	A1.6 Multiplication by a scalar	201
8.3 Input of data	116	A1.7 Matrix multiplication	201
8.4 Two-dimensional analyses	117	A1.8 References	203
8.5 Three-dimensional reconstruction	119		
8.6 Three-dimensional reconstruction of neurones (CELL)	126	<b>Appendix 2: A Graphics Glossary</b>	204
8.7 Three-dimensional reconstruction of non-neuronal tissue (RECON)	131		
8.8 Other three-dimensional reconstruction programs	139	<b>Index</b>	208
8.9 References and bibliography	140		
<b>9. Image Capture and Image Analysis</b>	143		
9.1 Biological images	143		
9.2 Image capture devices	143		