

COMPUTER GRAPHICS

Dr. SANJAY SHARMA POKHRIYAL

(COE & Assistant Professor)

**Department of Computer Science
SGRRITS, Dehradun, Uttarakhand, INDIA.**

Mr. HARISH SHARMA

(Assistant Professor)

**Department of Computer Science
SGRRITS, Dehradun, Uttarakhand, INDIA.**

COMPUTER GRAPHICS

Copyright © : Dr. Sanjay Sharma Pokhriyal
Publishing Right © : VSRD Academic Publishing
A Division of Visual Soft India Pvt.Ltd.

ISBN-13: 978-93-86258-10-6
FIRST EDITION, NOVEMBER 2016, INDIA

Typeset, Printed & Published by:
VSRD Academic Publishing (A Division of Visual Soft India Pvt. Ltd.)

Disclaimer: The author(s) are solely responsible for the contents of the papers compiled in this book. The publishers or its staff do not take any responsibility for the same in any manner. Errors, if any, are purely unintentional and readers are requested to communicate such errors to the Editors or Publishers to avoid discrepancies in future.

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording or otherwise, without the prior permission of the Publishers & Author.

Printed & Bound in India

VSRD ACADEMIC PUBLISHING
A Division of Visual Soft (India) Pvt. Ltd.

REGISTERED OFFICE

154, Tezabmill Campus, Anwarganj, KANPUR – 208003 (UP) (IN)
Mb: 9956127040, Web: www.vsrdpublishing.com, Email: vsrdpublishing@gmail.com

MARKETING OFFICE (NORTH INDIA)

Basement-2, Villa-10, Block-V, Charmwood Village, FARIDABAD–121009 (HY)(IN)
Mb: 9899936803, Web: www.vsrdpublishing.com, Email: vsrdpublishing@gmail.com

MARKETING OFFICE (SOUTH INDIA)

340, FF, Adarsh Nagar, Oshiwara, Andheri(W), MUMBAI–400053 (MH)(IN)
Mb: 9956127040, Web: www.vsrdpublishing.com, Email: vsrdpublishing@gmail.com

P R E F A C E

The ever increasing advance in computer technology has enabled many in science and engineering who apply graphics to simulate physical phenomena.

The interesting feature of this book is its organization and structure that consist of systematized definition, graphics, algorithms, exercise, methods and result that something resembling a theory. Simplicity clarity of graphical, mathematical language makes theoretical topics more appealing to the reader who is of mathematical or non-mathematical background.

My experience in teaching the computer graphics subject has help me to present a useful combination of theoretical concepts and practical application in this book. I am sure that the text users friendly approach by encourage the students to read to read the book and will make them understand the concept in a easy way. I welcome suggestion for the improvement of the book

Dr. Sanjay Sharma Pokhriyal

ACKNOWLEDGEMENT

First of all I would like to thanks almighty GOD who gave me an inspiration to take up this task.

I express my profound thanks to my mother Mrs Pushpa Sharma, brother Ashu Sharma, Wife Dr Nirupama Pokhriyal who have cultivated devotion and determination in me and have been a deep source of wisdom and inspiration for such initiative.

I am thankful to Sandeep chopra who inspire me in long way and all my near and dear who support me to cultivate my idea to write on paper.

My sincere thanks to Dr. H.S. Dhami, Vice Chancellor, Kumaun University, Dr. M.M.S. Rauthan, Professor DEAN, HNB, Dr. Ashish Uniyal, C.O.E., UTU, Dehradun, Dr. K Bhatiya, Gurukul Kangri University, Haridwar, Dr. A.K. Das, Director General, AMS and my research Guide too.

I would like to express my affection appreciation to my wife Dr. Nirupam Pokhriyal and loving daughter Bhoomi Pokhriyal whose precious & cheerful time I pilfered time to time to fulfill the task in time.

Any suggestions for improving the content would be warmly apriciated.

✍ Dr. Sanjay Sharma Pokhriyal

CONTENTS

CHAPTER 1

INTRODUCTION TO COMPUTER GRAPHICS 1

1.	INTRODUCTION	1
2.	INTERACTIVE COMPUTER GRAPHICS	2
3.	PASSIVE COMPUTER GRAPHICS	2
4.	APPLICATIONS	2
4.1	PRESENTATION GRAPHICS.....	2
4.2	COMPUTER AIDED DESIGN (CAD).....	3
4.3	COMPUTER ART.....	3
4.4	ENTERTAINMENT.....	4
4.5	EDUCATION AND TRAINING	4
4.6	VISUALIZATION	4
4.7	IMAGE PROCESSING	5
4.8	GRAPHICAL USER INTERFACE (GUI).....	6

CHAPTER 2

GRAPHICS SYSTEMS..... 7

1.	INTRODUCTION	7
2.	DISPLAY DEVICES	7
2.1	CATHODE RAY TUBE (CRT).....	7
2.2	RANDOM SCAN DISPLAY.....	9
2.3	RASTER SCAN DISPLAY.....	10
2.4	DIRECT VIEW STORAGE TECHNIQUES (DVST).....	12
3.	FLAT-PANEL DISPLAYS	13
3.1	EMISSIVE DISPLAYS.....	13
3.2	NON-EMISSIVE DISPLAYS.....	13
3.3	PLASMA PANEL DISPLAY.....	14
3.4	LIQUID CRYSTAL DISPLAY (LCD).....	15
4.	THREE DIMENSIONAL VIEWING DEVICES	16
5.	HARD COPY DEVICES	17

5.1	PRINTERS	18
5.2	PLOTTER.....	18
6.	INPUT DEVICE.....	19
6.1	KEYBOARD	19
6.2	MOUSE.....	20
6.3	TRACK BALL.....	21
6.4	SPACE BALL	21
6.5	JOYSTICK	21
6.6	DIGITIZERS	22
6.7	LIGHT PENS	23
6.8	DIALS.....	23
6.9	DATA GLOVE	23
6.10	TOUCH PANELS	24
6.11	IMAGE SCANNER.....	25
7.	VOICE SYSTEMS.....	25
8.	DISPLAY PROCESSOR	26
9.	VIDEO CONTROLLER	26
10.	RASTER-SCAN DISPLAY PROCESSOR	27
11.	RANDOM SCAN DISPLAY PROCESSOR.....	30

CHAPTER 3
OUTPUT PRIMITIVES..... 33

1.	INTRODUCTION	33
2.	LINE DRAWING ALGORITHMS.....	33
3.	DDA ALGORITHM	35
4.	PROCEDURE	37
5.	BRESENHAM’S LINE ALGORITHM.....	42
6.	CIRCLE GENERATING ALGORITHMS	52
7.	CIRCLE EQUATIONS	54
8.	BRESENHAM’S CIRCLE ALGORITHM	55

CHAPTER 4
TWO DIMENSIONAL TRANSFORMATIONS.....61

1. INTRODUCTION	61
2. BASIC TRANSFORMATIONS.....	61
2.1 TRANSLATION	62
2.2 ROTATION	63
2.3 SCALING	66
3. MATRIX REPRESENTATION AND HOMOGENEOUS COORDINATES	68
4. TRANSLATION TRANSFORMATION	69
5. ROTATION TRANSFORMATION	70
6. SCALING TRANSFORMATION	70
7. REFLECTION TRANSFORMATION.....	71
8. SHEAR TRANSFORMATION	72
9. OTHER TRANSFORMATIONS	72
10. REFLECTION TRANSFORMATION.....	72
10.1 REFLECTION ABOUT X-AXIS	73
10.2 REFLECTION ABOUT Y-AXIS	74
10.3 REFLECTION ABOUT ORIGIN (XY-AXIS)	75
10.4 REFLECTION ABOUT LINE $Y = X$	76
10.5 REFLECTION ABOUT LINE $Y = -X$	77
10.6 REFLECTION ABOUT AN ARBITRARY LINE	78

CHAPTER 5
TWO DIMENSIONAL VIEWING.....83

1. WINDOWING	83
2. CLIPPING	84
3. TYPES OF CLIPPING	85
3.1 POINT CLIPPING	85
3.2 LINE CLIPPING	86
4. COHEN-SUTHERLAND ALGORITHM	91

5.	POLYGON CLIPPING	96
6.	TEXT CLIPPING	97
7.	WINDOW-TO-VIEWPORT TRANSFORMATION	98

CHAPTER 6

INTERACTIVE INPUT METHODS101

1.	LOGICAL CLASSIFICATION OF INPUT DEVICES	101
1.1	LOCATOR DEVICES	102
1.2	STROKE DEVICES	102
1.3	STRING DEVICES.....	102
1.4	VALUATOR DEVICE.....	103
1.5	CHOICE DEVICE	103
1.6	PICK DEVICE	104
2.	INTERACTIVE PICTURE CONSTRUCTION TECHNIQUES.....	104
2.1	BASIC POSITIONING METHODS.....	105
2.2	CONSTRAINTS	106
2.3	GRIDS	107
2.4	GRAVITY FIELD	108
2.5	RUBBER BAND METHODS	109
2.6	DRAGGING	109
2.7	PAINTING AND DRAWING.....	110
2.8	INKING	111
2.9	POSITIONING	111
3.	INPUT FUNCTIONS.....	112
4.	INPUT MODES	112
4.1	REQUEST MODE.....	112
4.2	SAMPLE MODE.....	113
4.3	EVENT MODE	113

CHAPTER 7

THREE DIMENSIONAL CONCEPTS115

1.	PARALLEL PROJECTION.....	115
2.	PERSPECTIVE PROJECTION.....	116

3.	INTENSITY CUING	116
4.	HIDDEN-LINE REMOVAL.....	117
5.	HIDDEN-SURFACE REMOVAL AND SHADING.....	117
6.	EXPLODED AND CUTAWAY VIEWS	117
7.	THREE-DIMENSIONAL AND STEREOSCOPIC VIEWS.....	118

CHAPTER 8

THREE DIMENSIONAL TRANSFORMATIONS..... 119

1.	BASIC TRANSFORMATIONS.....	119
1.1	TRANSLATION	119
1.2	ROTATION	121
1.3	SCALING	126
2.	OTHER TRANSFORMATIONS	127
3.	REFLECTION TRANSFORMATION.....	128
4.	MIRROR REFLECTION ABOUT XY-PLANE	128
5.	MIRROR REFLECTION ABOUT YZ-PLANE.....	129
6.	MIRROR REFLECTION ABOUT XZ-PLANE	131
7.	SHEARING	132
7.1	SHEAR IN Z-AXIS.....	132
7.2	SHEAR IN Y-AXIS.....	134
7.3	SHEAR IN X-AXIS	135
7.4	SHEAR IN XYZ-AXIS.....	136

CHAPTER 9

THREE DIMENSIONAL VIEWING..... 138

1.	PROJECTIONS.....	138
1.1	PARALLEL PROJECTIONS	140
1.2	ORTHOGRAPHIC PROJECTION	140
1.3	OBLIQUE PROJECTION	140
1.4	OBLIQUE PROJECTION	142
1.5	PERSPECTIVE PROJECTIONS.....	146

CHAPTER 10

HIDDEN SURFACE AND HIDDEN LINE REMOVAL149

1. CLASSIFICATION OF ALGORITHMS	149
1.1 OBJECT SPACE METHOD	149
1.2 IMAGE SPACE METHOD	150
2. BACK FACE REMOVAL.....	150
3. DEPTH BUFFER METHOD	152
4. ALGORITHM	153
4.1 ADVANTAGES.....	155
4.2 DISADVANTAGE	155
5. A-BUFFER METHOD	156
6. SCAN -LINE METHOD	158
7. AREA-SUBDIVISION METHOD	160
8. IMPLEMENTATION	161
9. CHARACTERISTICS (TESTS)	161
9.1 TEST-1	162
9.2 TEST-2	162
9.3 TEST-3	163