#### Visual Computing: Geometry, Graphics, and Vision.

Frank Nielsen,

Charles River Media Press, June 2005.

ISBN: 1-58450-427-7

## Chapter 1 Introduction

- 1.1 What Is Visual Computing?
- 1.2 Target Audience
- 1.3 Organization of the Book
- 1.4 Future of Visual Computing
- 1.5 Companion Web Site

#### Chapter 2 Abstract Data Structures

- 2.1 Pointers, Arrays, Lists, and Graphs
  - 2.1.1 Pointers
  - 2.1.2 Arrays

Images as Bidimensional Arrays

Multidimensional Arrays

- 2.1.3 Singly and Doubly Linked Lists
- 2.1.4 Graphs

Adjacency Matrices

Adjacency Lists

Trees

Images as Graphs

- 2.2 Stacks and Queues
  - 2.2.1 Application: Area Floodfilling
  - 2.2.2 Recursive Algorithm
  - 2.2.3 Floodfilling Using Stacks
  - 2.2.4 Floodfilling Using Queues
  - 2.2.5 Implementing Stacks and Queues
- 2.3 Dictionaries
  - 2.3.1 Unordered Dictionaries
  - 2.3.2 Ordered Dictionaries
  - 2.3.3 Application: Detecting Any Segment Pair Intersection
- 2.4 Priority Queues
  - 2.4.1 Primitives
  - 2.4.2 Application: Reporting All Segment Intersections
- 2.5 Disjoint Sets
  - 2.5.1 Application: Image Segmentation
  - 2.5.2 Union-Find Data Structure
- 2.6 Geometric Hashing
  - 2.6.1 Hashing by Chaining
  - 2.6.2 Application: Object Recognition
  - 2.6.3 Hashing Point Sets
- 2.7 C++ Templates, Standard Template Library, and Traits Classes
  - 2.7.1 Template Classes
  - 2.7.2 C++ Standard Template Library

2.7.3 Traits Classes

Handling Constants

Unifying Types

Geometric Traits Classes

2.8 Bibliographical Notes

#### Chapter 3 Coordinate Pipelines

- 3.1 Transformation Principles
  - 3.1.1 Coordinate Systems versus Modeling Transformations

Local and Global Coordinate Systems

Modeling Transformations

- 3.1.2 Transformations as Matrices
- 3.1.3 Homogeneous and Inhomogeneous Coordinates
- 3.2 Geometry Pipeline
  - 3.2.1 2D Transformations
  - 3.2.2 3D Transformations
  - 3.2.3 Rotations as Quaternions
  - 3.2.4 Normal Transformations
- 3.3 Graphics Pipeline
  - 3.3.1 Transformation Hierarchies
  - 3.3.2 Scene Graphs
  - 3.3.3 Viewing Transformations
  - 3.3.4 Projections

Orthographic Projections

Perspective Projections

3.3.5 3D Clippings and Projection Transformations

Orthographic Canonical View Volume

Perspective Truncated Pyramid

View Plane Clipping

- 3.4 Vision Pipelines
  - 3.4.1 Homographies
  - 3.4.2 Camera Calibrations
  - 3.4.3 Extrinsic and Intrinsic Camera Parameters

Pinhole Camera

- 3.4.4 Epipolar Geometry
- 3.5 Advanced Pipelines
  - 3.5.1 Log-Polar Transform
  - 3.5.2 Cylindrical and Spherical Coordinates
  - 3.5.3 Polarity
  - 3.5.4 Conics and Quadrics
  - 3.5.5 Plücker Coordinates
  - 3.5.6 Eigenvectors and Matrix Diagonalization
  - 3.5.7 Singular Value Decomposition (SVD)
  - 3.5.8 Taxonomy of Projections
  - 3.5.9 Cameras with Lenses
  - 3.5.10 Tangent Spaces
  - 3.5.11 Environment maps
- 3.6 Summary and Perspectives
- 3.7 Bibliographical Notes

#### Chapter 4 Images

- 4.1 Application: Warping and Morphing Images
  - 4.1.1 Image Warping
  - 4.1.2 Morphing
  - 4.1.3 Compositing with Alpha Matting
  - 4.1.4 View Morphing
- 4.2 Interpolations
  - 4.2.1 Resampling & Anti-aliasing

Convolutions

Discrete Convolution Kernels

Fourier Analysis

Anti-Aliasing

Super-Sampling

Reconstruction Filters

Phase Correlation

- 4.2.2 Barycentric Coordinate Interpolations
- 4.2.3 Elliptical Weighted Average Interpolations
- 4.2.4 Super Resolution
- 4.3 Colors
  - 4.3.1 Radiometry and Photometry
  - 4.3.2 Color Spaces

Color Matching and Chromaticity Diagram

XYZ Color Space

RGB Color Space

HLS and HSV Color Spaces

CMY(K) Color Space

L\*a\*b\* Color Space

Pseudo-Coloring and Other Miscellaneous Color Techniques

4.3.3 Physical Color Phenomena

Fluorescence and Phosphorescence

Iridescence

Fresnel Effect

4.3.4 Perceptual Color Phenomena

Simultaneous Constrast

Mach Bands

Color-Appearance Models

- 4.4 Halftoning and Dithering
  - 4.4.1 Digital Halftoning
  - 4.4.2 Dithering
- 4.5 High Dynamic Range Imaging
  - 4.5.1 Light Probes
  - 4.5.2 Tone Mapping
- 4.6 Image Pyramids
  - 4.6.1 Mipmappings
  - 4.6.2 Gaussian & Laplacian Pyramids
  - 4.6.3 Applications of Scaled Representations
- 4.7 Bibliographical Notes

#### Chapter 5 Meshes

- 5.1 Prelude to Meshes
  - 5.1.1 Polygons
  - 5.1.2 Polyhedra
- 5.2 Basic Mesh Descriptions
  - 5.2.1 Mesh Topology
  - 5.2.2 Modeling Meshes
  - 5.2.3 Triangulations and Tessellations
  - 5.2.4 Procedural Meshes
- 5.3 Data Structures for Meshes
  - 5.3.1 Static Meshes

Indexed Face List

- 5.3.2 Bandwidth Optimization
- 5.3.3 Winged-Edges
- 5.3.4 Half-Edges
- 5.3.5 Quad-Edges
- 5.4 Operations on Meshes
  - 5.4.1 Fairing Meshes
  - 5.4.2 Smooting Meshes by Subdivisions
  - 5.4.3 Remeshing
  - 5.4.4 Progressive Meshes
  - 5.4.5 Parameterization
- 5.5 Geometry Images
- 5.6 Alternative to Meshes
- 5.7 Bibliographical Notes

### Chapter 6 Animation

- 6.1 Kinetic Data Structures
- 6.2 Motion Capture
  - 6.2.1 Tracking
  - 6.2.2 Matchmoving
- 6.3 Computer Graphics Animation
  - 6.3.1 Keyframe animation
  - 6.3.2 Forward and Inverse Kinematics
  - 6.3.3 Active versus Passive Dynamics
  - 6.3.4 Particle Systems
  - 6.3.5 Animating Rotations by Quaternions
- 6.4 Bibliographical Notes

# Chapter 7 Randomization

- 7.1 Randomized Analysis of QuickSort
- 7.2 Random Sample Consensus
- 7.3 Monte-Carlo Samplings
- 7.4 Randomizing Incremental Algorithms
- 7.5 Randomized Incremental Optimization
- 7.6 Skip Lists
- 7.7 Bibliographical notes

# Chapter 8 Higher Dimensions for "3D"

8.1 Nearest Neighbours

8.1.1 Application: 2D Texture Synthesis

 $8.1.2~\mathrm{kD}\text{-Trees}$ 

8.2 Clustering

8.2.1 Application: Color Quantization

8.2.2 Clustering by kMeans

8.3 Mathematical Techniques

8.3.1 Linearization

Application: Closest Pair of Points Lifting for Designing Geometric Predicates

8.3.2 Approximating Distances in Large Dimensions

8.4 Bibliographical Notes

### Chapter 9 Robustness

- 9.1 Identifying Weaknesses and Defining Robustness
- 9.2 IEEE 754 Floating Point
- 9.3 Filtering Predicates
- 9.4 Predicate degrees
- 9.5 Overview of Libraries
- 9.6 Bibliographical Notes