

Contents

Part I	An Introduction to VTK	
Chapter 1	Welcome	3
1.1	User Guide Organization	3
1.2	How to Learn VTK.	4
1.3	Software Organization	4
	Obtaining The Software.	4
	Directory Structure	5
	Documentation.	5
	Data	6
1.4	Additional Resources	6
Chapter 2	Installation	7
2.1	Overview	7
2.2	CMake	8
2.3	Installing VTK on Windows 9x/NT/ME/2000/XP.	8
	Binary Installation	9
	Source Code Installation	10
2.4	Installing VTK on Unix Systems	13
	Source Code Installation	13
	CMake	13
	Compiling the Source Code.	15
	Building VTK On Multiple Platforms.	15
	Installing VTK.	16
Chapter 3	System Overview	17
3.1	System Architecture	17
	Low-Level Object Model	18
	The Graphics Model	19
	The Visualization Model	20
3.2	Create An Application	25
	User Methods, Observers, and Commands	25
	Tcl	26
	C++	27
	Java	32
	Python	33
	Visual Basic / COM / ActiveX	33
3.3	Conversion Between Languages	33

Part II Learn VTK By Example

Chapter 4	The Basics	37
4.1	Creating Simple Models	38
	Procedural Source Object	38
	Reader Source Object	40
4.2	Using VTK Interactors	41
	vtkRenderWindowInteractor	41
	Interactor Styles	43
4.3	Filtering Data	44
4.4	Controlling The Camera	45
	Instantiating The Camera	45
	Simple Manipulation Methods	46
	Controlling The View Direction	46
	Perspective Versus Orthogonal Views	46
	Saving/Restoring Camera State	47
4.5	Controlling Lights	47
	Positional Lights	47
4.6	Controlling 3D Props	48
	Specifying the Position of a vtkProp3D	48
	Actors	49
	Level-Of-Detail Actors	51
	Assemblies	52
	Volumes	53
	vtkLODProp3D	53
4.7	Using Texture	54
4.8	Picking	55
	vtkAssemblyPath	56
	Example	57
4.9	vtkCoordinate and Coordinate Systems	58
4.10	Controlling vtkActor2D	58
4.11	Annotation	59
	2D Annotation	59
	3D Annotation and vtkFollower	61
4.12	Special Plotting Classes	62
	Scalar Bar	62
	X-Y Plots	62
	Bounding Box Axes (vtkCubeAxesActor2D)	63
	Labeling Data	64
4.13	Transforming Data	66
	Advanced Transformation	67
	3D Widgets	67
Chapter 5	Visualization Techniques	73
5.1	Visualizing vtkDataSet (and Subclasses)	73
	Working With Data Attributes	73
	Color Mapping	76
	Contouring	77
	Glyphing	78
	Streamlines	79

	Stream Surfaces	82
	Cutting	83
	Merging Data	83
	Appending Data	84
	Probing	85
	Color An Isosurface With Another Scalar	87
	Extract Subset of Cells	87
	Extract Cells as Polygonal Data	89
5.2	Visualizing Polygonal Data	90
	Manually Create vtkPolyData	90
	Generate Surface Normals	91
	Decimation	92
	Smooth Mesh	93
	Clip Data	94
	Generate Texture Coordinates	95
5.3	Visualizing Structured Grids	96
	Manually Create vtkStructuredGrid	97
	Extract Computational Plane	97
	Subsampling Structured Grids	98
5.4	Visualizing Rectilinear Grids	98
	Manually Create vtkRectilinearGrid	98
	Extract Computational Plane	99
5.5	Visualizing Unstructured Grids	99
	Manually Create vtkUnstructuredGrid	99
	Extract Portions of the Mesh	100
	Contour Unstructured Grids	101

Chapter 6 Image Processing & Visualization 103

6.1	Historical Note on vtkStructuredPoints	104
6.2	Manually Creating vtkImageData	104
6.3	Subsampling Image Data	105
6.4	Warp Based On Scalar Values	106
6.5	Image Display	108
	Image Viewer	108
	Image Actor	108
6.6	Image Sources	109
	ImageCanvasSource2D	109
	ImageEllipsoidSource	110
	ImageGaussianSource	110
	ImageGridSource	110
	ImageNoiseSource	111
	ImageSinusoidSource	111
6.7	Image Processing	111
	Convert Scalar Type	112
	Change Spacing, Origin, or Extent	112
	Append Images	113
	Map Image to Color	114
	Image Luminance	115
	Histogram	115
	Image Logic	116
	Gradient	116

	Gaussian Smoothing	117
	Image Flip	117
	Image Permute	118
	Image Mathematics	118
	Image Reslice	120
Chapter 7	Volume Rendering	123
7.1	Historical Note on Supported Data Types	124
7.2	A Simple Example	124
7.3	Why Multiple Volume Rendering Techniques?	126
7.4	Creating a vtkVolume	127
7.5	Using vtkPiecewiseFunction	127
7.6	Using vtkColorTransferFunction	128
7.7	Controlling Color / Opacity with a vtkVolumeProperty	128
7.8	Controlling Shading with a vtkVolumeProperty	131
7.9	Creating a Volume Mapper	133
7.10	Historical Note on VolumePro Mappers	134
7.11	Cropping a Volume	134
7.12	Clipping a Volume	135
7.13	Controlling the Normal Encoding	136
7.14	Volumetric Ray Casting for vtkImageData	137
7.15	Fixed Point Ray Casting	140
7.16	2D Texture Mapping	140
7.17	3D Texture Mapping	140
7.18	Volumetric Ray Casting for vtkUnstructuredGrid	141
7.19	ZSweep	142
7.20	Projected Tetrahedra	143
7.21	Speed vs. Accuracy Trade-offs	143
7.22	Using a vtkLODProp3D to Improve Performance	144
7.23	Capabilities / Limitation of the Techniques	145
Chapter 8	Building Models	147
8.1	Implicit Modeling	147
	Creating An Implicit Model	147
	Sampling Implicit Functions	149
8.2	Extrusion	151
8.3	Constructing Surfaces	152
	Delaunay Triangulation	152
	Gaussian Splatting	156
	Surfaces from Unorganized Points	159
Chapter 9	Data Interface & Miscellaneous	161
9.1	Readers	161
	Polygonal Data Readers	161
	Image and Volume Readers	162
	Structured Grid Readers	162
	Rectilinear Grid Readers	162
	Unstructured Data Readers	163
	Data Set Readers	163
	Hierarchical Data Readers	163
	Parallel Data Readers	163

9.2	Writers	164
	Polygonal Data Writers	164
	Image and Volume Writers	164
	Structured Grid Writers	165
	Rectilinear Grid Writers	165
	Unstructured Grid Writers	165
	Data Set Writers	165
	Parallel Data Writers	165
9.3	Importers	166
9.4	Exporters	166
9.5	Creating Hardcopy	167
	Saving Images	167
	Saving Large (High-Resolution) Images	167
9.6	Creating Animations (Using Splines)	168
9.7	Creating Movie Files	170
9.8	Working With Field Data	170

Part III VTK Developer's Guide

Chapter 10	Contributing Code	177
10.1	Coding Considerations	177
	Conditions on Contributing Code To VTK	177
	Coding Style	179
	How To Contribute Code	179
10.2	Standard Methods: Creating and Deleting Objects	180
10.3	Copying Objects and Protected Methods	182
10.4	Using STL	183
10.5	Managing Include Files	184
10.6	Writing A VTK Class: An Overview	185
	Find A Similar Class	185
	Identify A Superclass	185
	Single Class Per .h File	185
	Required Methods	186
	Document Code	186
	Use SetGet Macros	186
	Add Class To VTK	187
10.7	Object Factories	187
	Overview	187
	How To Write A Factory	188
	How To Install A Factory	189
	Example Factory	190
10.8	The VTK Software Process	192
	CVS Source Code Repository	192
	DART Regression Testing System	193
	Working The Process	194
	The Effectiveness of the Process	195
Chapter 11	Managing Pipeline Execution	197
11.1	Information Objects	198
11.2	Pipeline Execution Models	199
11.3	Pipeline Information Flow	200
11.4	Interface of Information Objects	201
11.5	Standard Executives	203
	vtkDemandDrivenPipeline	203
	vtkStreamingDemandDrivenPipeline	205
Chapter 12	Interfacing To VTK Data Objects	207
12.1	Data Arrays	207
	Methods	208
12.2	Datasets	213
12.3	Interface to vtkDataSet	215
	Methods	215
	Examples	218
12.4	Interface to vtkImageData	219
	Methods	219
	Example	220
12.5	Interface to vtkRectilinearGrid	221

	Description	221
	Methods	222
12.6	Interface to vtkPointSet	223
	Methods	223
	Example	224
12.7	Interface To vtkStructuredGrid	224
	Methods	224
12.8	Interface to vtkPolyData	225
	Methods	227
12.9	Interface to vtkUnstructuredGrid	230
	Access Methods	230
12.10	Interface to Cells (Subclasses of vtkCell)	232
12.11	Miscellaneous Interfaces	235
	vtkPoints	235
	vtkCellArray	237
	vtkCellTypes	239
	vtkCellLinks	240
12.12	Interface to Field and Attribute Data	241
	vtkFieldData Methods	242
	vtkDataSetAttributes Methods	244
Chapter 13	How To Write an Algorithm for VTK	249
13.1	Overview	249
	The Pipeline Interface	249
	The User Interface	252
	Fulfilling Pipeline Requests	253
13.2	Laws of VTK Algorithms	254
	Never Modify Input Data	254
	Reference Count Data	254
	Use Debug Macros	255
	Reclaim/Delete Allocated Memory	255
	Compute Modified Time	255
	Use ProgressEvent and AbortExecute	257
	Implement PrintSelf() Methods	258
	Get Input/Output Data From Pipeline Information	258
13.3	Example Algorithms	258
	A Graphics Filter	259
	A Simple Imaging Filter	263
	A Threaded Imaging Filter	265
	A Simple Reader	271
	A Streaming Filter	273
	An Abstract Filter	276
	Programmable Filters	280
Chapter 14	Integrating With The Windowing System	283
14.1	vtkRenderWindow Interaction Style	283
14.2	General Guidelines for GUI Interaction	285
14.3	X Windows, Xt, and Motif	289
14.4	MS Windows / Microsoft Foundation Classes	294
14.5	Tcl/Tk	294

14.6	Java	296
Chapter 15	Coding Resources	297
15.1	Object Diagrams	297
	Foundation	297
	Cells	297
	Datasets	298
	Topology and Attribute Data	298
	Pipeline	298
	Sources and Filters	299
	Mappers	300
	Graphics	300
	Volume Rendering	300
	Imaging	301
	OpenGL Renderer	301
	Picking	301
	Transformation Hierarchy	302
15.2	Summary Of Filters	302
	Source Objects	302
	Imaging Filters	308
	Visualization Filters	313
	Mapper Objects	321
	Actor (Prop) Objects	322
15.3	VTK File Formats	323
	Simple Legacy Formats	324
	XML File Formats	336
Chapter 16	CD-ROM	347
16.1	Source Code	347
16.2	Example Code	347
16.3	Windows 9x/NT/ME/2000/XP Pre-Compiled Binaries	348
16.4	Data	348
16.5	Documentation	348
16.6	Regression Test Images	348
16.7	Kitware Applications	348