Contents

	Foreword Preface		xiii xvii
I	Foι	undations	1
1	Introduction		3
	1.1	Structure of a Typical Game Team	5
	1.2	What Is a Game?	8
	1.3	What Is a Game Engine?	11
	1.4	Engine Differences Across Genres	13
	1.5	Game Engine Survey	25
	1.6	Runtime Engine Architecture	28
	1.7	Tools and the Asset Pipeline	49
2	Tools of the Trade		57
	2.1	Version Control	57
	2.2	Microsoft Visual Studio	66
	2.3	Profiling Tools	85

	2.4	Memory Leak and Corruption Detection	87
	2.5	Other Tools	88
3	Fundamentals of Software		
	Engineering for Games		91
	3.1	C++ Review and Best Practices	91
	3.2	Data, Code, and Memory in C/C++	98
	3.3	Catching and Handling Errors	128
4	3D Math for Games		137
	4.1	Solving 3D Problems in 2D	137
	4.2	Points and Vectors	138
	4.3	Matrices	151
	4.4	Quaternions	169
	4.5	Comparison of Rotational Representations	177
	4.6	Other Useful Mathematical Objects	181
	4.7	Hardware-Accelerated SIMD Math	185
	4.8	Random Number Generation	192
H	Lov	v-Level Engine Systems	195
5	Engine Support Systems		197
	5.1	Subsystem Start-Up and Shut-Down	197
	5.2	Memory Management	205
	5.3	Containers	223
	5.4	Strings	242
	5.5	Engine Configuration	252
6	Resources and the File System		261
	6.1	File System	262
	6.2	The Resource Manager	272
7	The Game Loop and Real-Time Simulation		303
	7.1	The Rendering Loop	303
	7.2	The Game Loop	304
		-	

Contents

	7.3	Game Loop Architectural Styles	307
	7.4	Abstract Timelines	310
	7.5	Measuring and Dealing with Time	312
	7.6	Multiprocessor Game Loops	324
	7.7	Networked Multiplayer Game Loops	333
8	Human Interface Devices (HID)		339
	8.1	Types of Human Interface Devices	339
	8.2	Interfacing with a HID	341
	8.3	Types of Inputs	343
	8.4	Types of Outputs	348
	8.5	Game Engine HID Systems	349
	8.6	Human Interface Devices in Practice	366
9	Tools for Debugging and Development		367
	9.1	Logging and Tracing	367
	9.2	Debug Drawing Facilities	372
	9.3	In-Game Menus	379
	9.4	In-Game Console	382
	9.5	Debug Cameras and Pausing the Game	383
	9.6	Cheats	384
	9.7	Screen Shots and Movie Capture	384
	9.8	In-Game Profiling	385
Ш	Gra	phics and Motion	397
10	The Rendering Engine		399
	10.1	Foundations of Depth-Buffered	100
	10.2	Triangle Rasterization	400
	10.2	The Rendering Pipeline	444
	10.3	Advanced Lighting and Global Illumination	469
	10.4	Visual Effects and Overlays	481
11	Animation Systems		491
	11.1	Types of Character Animation	491
	11.2	Skeletons	496

	11.3	Poses	499
	11.4	Clips	504
	11.5	Skinning and Matrix Palette Generation	518
	11.6	Animation Blending	523
	11.7	Post-Processing	542
	11.8	Compression Techniques	545
	11.9	Animation System Architecture	552
	11.10	The Animation Pipeline	553
	11.11	Action State Machines	568
	11.12	Animation Controllers	593
12	Collision and Rigid Body Dynamics		595
	12.1	Do You Want Physics in Your Game?	596
	12.2	Collision/Physics Middleware	601
	12.3	The Collision Detection System	603
	12.4	Rigid Body Dynamics	630
	12.5	Integrating a Physics Engine into Your Game	666
	12.6	A Look Ahead: Advanced Physics Features	684
IV	Gar	neplay	687
13	Introduction to Gameplay Systems		689
	13.1	Anatomy of a Game World	690
	13.2	Implementing Dynamic Elements: Game Objects	695
	13.3	Data-Driven Game Engines	698
	13.4	The Game World Editor	699
14	Runtime Gameplay Foundation Systems		711
	14.1	Components of the Gameplay Foundation System	711
	14.2	Runtime Object Model Architectures	715
	14.3	World Chunk Data Formats	734
	14.4	Loading and Streaming Game Worlds	741
	14.5	Object References and World Queries	750
	14.6	Updating Game Objects in Real Time	757
	14.0	Upualing Jaine Upiells in Real Hille	131

Contents

	14.7	Events and Message-Passing	773
	14.8	Scripting	794
	14.9	High-Level Game Flow	817
V	Со	nclusion	819
15	You	Mean There's More?	821
	15.1	Some Engine Systems We Didn't Cover	821
	15.2	Gameplay Systems	823
	References		827
	Index		831