Cloth Modeling and Animation

Edited by

Donald H. House

David E. Breen



A K Peters Natick, Massachusetts

Table of Contents

1	Woven Fabrics			
	1.1	Introduction	1	
	1.2	Choices	4	
	1.3	Conclusion	17	
2	2 A Survey of Cloth Modeling Methods			
	2.1	Contributions of the Textile Community	20	
	2.2	Contributions of the Computer Graphics Community	35	
3	Particle Representation of Woven Fabrics		55	
	3.1	Introduction	55	
	3.2	Modeling Drape with Particles	57	
	3.3	Modeling a Variety of Cloth Types	62	
	3.4	Extending the Drape Model to Include Dynamics	69	
	3.5	Conclusion	76	
4	Con	tinuum versus Particle Representations	79	
	4.1	Introduction	79	
	4.2	Finite-Element Continuum Modeling of Cloth	79	
	4.3	Particle Modeling of Cloth	92	
	4.4	Results: Comparing Finite Element and Particle Methods	100	
	4.5	Clothing Drape Results	107	
	4.6	Conclusions	107	
	4.8	Appendix—Details of the Nonlinear Shell Theory	107	

5	Kni	t Fabrics	123
	5.1	Introduction	123
	5.2	Representation of Knit Fabrics	124
	5.3	The Draping of Fabrics	133
6	Rap	id Dynamic Simulation	145
	6.1	Introduction	145
	6.2	Simulation Overview	149
	6.3	Implicit Integration	152
	6.4	Forces	153
	6.5	Constraints	158
	6.6	Implementation	162
	6.7	Collisions	165
	6.8	Adaptive Time-Stepping	168
	6.9	Results	169
7	Aer	odynamic Effects	175
	7.1	Introduction	175
	7.2	Distributed-Force Model for the Coth-Animation Problem	176
	7.3	Two-Dimensional Implementation of the Panel Method	178
	7.4	Three-Dimensional Implementation of the Panel Method	181
	7.5	Effect of a Solid Object in the Vicinity of the Cloth	182
	7.6	Wind Model and Simulation	186
	7.7	Implementation	189
	7.8	Conclusions	190
	7.9	Appendix: Vortex Singularities and their Induced Velocity	191
8	Coll	ision Detection in Cloth Modeling	197
	8.1	Introduction	197
	8.2	Overview	198
	8.3	The Collision Algorithm	199
	8.4	Run-Time Algorithm Path	214
	8.5	Results and Conclusions	214
9	Interactive Animation of Cloth-Like Objects for Virtual Reality		
	9.1	Introduction	219
	9.2	Implicit Integration: ID Case	221
	9.3	An Extension to 2D and 3D	227
	9.4	Post-Step Constraint Enforcement	230
	9.5	Animation Algorithm	232
	9.6	Results	233
	9.7	Conclusion and Discussion	236

10	From Structure to Reflectance	241
	10.1 Scale	243
	10.2 Bidirectional Reflectance Distribution Function	245
	10.3 Distribution of Normals	248
	10.4 Modeling Distributions of Normals	250
	10.5 Multiple Surfaces	258
	10.6 Shadowing and Masking	261
	10.7 Summary	265
11	A Volumetric Appearance Model	269
	11.1 Introduction	269
	11.2 Simple Knitted Fabric Patterns	270
	11.3 Modeling of the Yarn Micro-structure	273
	11.4 Efficient Rendering of Knitted Fabrics	276
	11.5 Examples of Yarns and Patterns	278
	11.6 Summary	283
12	A Costume Designer and Animator's Perspective	287
	12.1 Background	288
	12.2 Factors Affecting Drape and Movement	292
	12.3 The Complexity of Garments	295
	12.4 The Costume Design Process	302
	12.5 Digital Cloth	306
13	Clothing in Disney's "FANTASIA 2000"	309
	13.1 Introduction	309
	13.2 The Problem	311
	13.3 The Model	311
	13.4 Animation and Deformation	314
	13.5 Post-Simulation Processes	323
	13.6 Implementation	324
	13.7 Conclusion	325
14	Conclusion	327
	14.1 CG Cloth Goes Hollywood	328
	14.2 A Holy Grail?	332
	14.3 Research Directions	334
	14.4 Postlude	336