

Contents

Preface	v
List of Figures	xvii
List of Tables	xxxiii
1	
Introduction	1
<i>Katsushi Ikeuchi and Daisuke Miyazaki</i>	
1. Range Sensor	2
2. Range Data Analysis	3
3. Photometric Modelling	6
4. Utilizing Digital Data for Archaeological Investigation	7
Acknowledgments	9
References	9
 Part I Range Sensor	
2	
Shape Rectification of 3D Data Obtained by a Moving Range Sensor by using Image Sequences	13
<i>Atsuhiko Banno and Katsushi Ikeuchi</i>	
1. Introduction	13
2. Full Perspective Factorization	15
3. Refinement	19
4. FLRS	21
5. Experiments	23
6. Conclusions	26
Acknowledgments	26
References	26
3	
The Climbing Sensor: 3D Modeling of Narrow Areas by Using Space- Time Analysis	33
<i>Shintaro Ono, Ken Matsui, and Katsushi Ikeuchi</i>	
1. Introduction	33
2. Spatiotemporal Range Image	35
3. Localizing Algorithm for 3D Modeling	38
4. System Configuration	39

5.	Experiment and Modeling Results	41
6.	Conclusion	44
	Acknowledgments	45
	References	46
4		
	Inverse Polarization Raytracing: Estimating Surface Shapes of Transparent Objects	49
	<i>Daisuke Miyazaki and Katsushi Ikeuchi</i>	
1.	Introduction	49
2.	Polarization Raytracing	51
3.	Inverse Polarization Raytracing	56
4.	Measurement Result	58
5.	Conclusion	63
	Acknowledgments	64
	References	64
	Part II Range Data Analysis	
5		
	Robust Simultaneous Registration of Multiple Range Images	71
	<i>Ko Nishino and Katsushi Ikeuchi</i>	
1.	Introduction	71
2.	Overview	72
3.	Point Mate Search	75
4.	Least-square Minimization Strategy	79
5.	Results	82
6.	Conclusion and Future Work	84
	Acknowledgments	85
	References	86
6		
	A Fast Simultaneous Alignment of Multiple Range Images	89
	<i>Takeshi Oishi, Atsushi Nakazawa, Ryo Kurazume, and Katsushi Ikeuchi</i>	
1.	Introduction	89
2.	Alignment Algorithm	91
3.	Experimental Results	99
4.	Conclusion	104
	Acknowledgments	106
	References	106
7		
	Parallel Alignment of a Large Number of Range Images	109
	<i>Takeshi Oishi, Ryusuke Sagawa, Atsushi Nakazawa, Ryo Kurazume, and Katsushi Ikeuchi</i>	
1.	Introduction	109
2.	Simultaneous Alignment Algorithm	110
3.	Parallel Alignment Based on a PC Cluster	112

<i>Contents</i>	xi
4. Performance Evaluation	118
5. Experimental Results	121
6. Conclusion	124
Acknowledgments	124
References	124
8	
Simultaneous Determination of Registration and Deformation Parameters among 3D Range Images	127
<i>Tomohito Masuda, Yuichiro Hirota, Ko Nishino, and Katsushi Ikeuchi</i>	
1. Introduction	127
2. Related Work	129
3. Robust Determination of Translation and Rotation Parameters	130
4. Simultaneous Determination of Deformation Parameters	132
5. Unknown Parameter Estimation of Mathematical Model	134
6. Inter-and-Intra Scanning Registration	138
7. Conclusion and Future Work	143
Acknowledgments	144
References	144
9	
Parallel Processing of Range Data Merging	147
<i>Ryusuke Sagawa, Ko Nishino, Mark D. Wheeler, and Katsushi Ikeuchi</i>	
1. Introduction	147
2. Data Merging	148
3. Increase the computation and memory efficiency	152
4. Parallel Computing of Signed Distances	153
5. Performance Evaluation	155
6. Conclusion	157
Acknowledgments	157
References	158
10	
Adaptively Merging Large-Scale Range Data with Reflectance Properties	161
<i>Ryusuke Sagawa, Ko Nishino, and Katsushi Ikeuchi</i>	
1. Introduction	161
2. Consensus Surface Algorithm	166
3. Adaptive Merging Algorithm	168
4. Adaptive Merging with Reflectance Properties	173
5. Adaptive Nearest Neighbor Search	177
6. Experiments	179
7. Conclusion	183
Appendix: Algorithm of BOT test	186
Acknowledgments	187
References	187
11	
Iterative Refinement of Range Images with Anisotropic Error Distribution	193

Ryusuke Sagawa, Takeshi Oishi, Atsushi Nakazawa, Ryo Kurazume, and Katsushi Ikeuchi

1.	Introduction	193
2.	Proposed Method	194
3.	Experiment	198
4.	Summary	203

Acknowledgments	204
-----------------	-----

References	205
------------	-----

12

Hole Filling of 3D Model by Flipping Signs of Signed Distance Field in Adaptive Resolution	207
--------------------------------------------------------------------------------------------	-----

Ryusuke Sagawa and Katsushi Ikeuchi

1.	Introduction	207
2.	Hole Filling by Minimizing the Curvature of the Interpolating Surface	209
3.	Computing Initial State from Real Surfaces	210
4.	Hole Filling by Minimizing the Area of Interpolating Surface	214
5.	Experiments	223
6.	Conclusion	231

Acknowledgments	232
-----------------	-----

References	232
------------	-----

Part III Color Analysis

13

Simultaneous Registration of 2D Images onto 3D Models for Texture Mapping	237
---------------------------------------------------------------------------	-----

Ryo Ohkubo, Ryo Kurazume, and Katsushi Ikeuchi

1.	Introduction	237
2.	Preliminaries	242
3.	2D-3D Registration Algorithm	246
4.	Simultaneous Registration Algorithm	258
5.	Experiments and Results	264
6.	Conclusions	267

Acknowledgments	268
-----------------	-----

References	268
------------	-----

14

Consistent Surface Color for Texturing Large Objects in Outdoor Scenes	279
------------------------------------------------------------------------	-----

Rei Kawakami, Robby T. Tan, and Katsushi Ikeuchi

1.	Introduction	280
2.	Reflection Model	281
3.	Estimating Surface Chromaticity	282
4.	Robust Framework for Outdoor Scenes	285
5.	Implementation and Experimental Results	289
6.	Conclusion	291

Appendix	293
----------	-----

Appendix 14.B	294
---------------	-----

<i>Contents</i>	xiii
Acknowledgments	294
References	294
15	
Separating Illumination and Surface Spectral from Multiple Color Signals	297
<i>Akifumi Ikari, Rei Kawakami, Robby T. Tan, and Katsushi Ikeuchi</i>	
1. Introduction	297
2. Theoretical Background	299
3. Proposed Method: Separation using Multiple Color Signals	301
4. Acquiring Scene Spectrums	307
5. Implementation	310
6. Experimental Results	311
7. Conclusion	319
Acknowledgments	319
References	319
16	
Color Constancy through Inverse-Intensity Chromaticity Space	323
<i>Robby T. Tan, Ko Nishino, and Katsushi Ikeuchi</i>	
1. Introduction	323
2. Reflection Model	326
3. Inverse-Intensity Chromaticity Space	328
4. Computational Method to Estimate Illumination Chromaticity	333
5. Discussion	334
6. Experimental Results	338
7. Conclusion	348
Acknowledgments	349
References	349
17	
Separating Reflection Components of Textured Surfaces using a Single Image	353
<i>Robby T. Tan and Katsushi Ikeuchi</i>	
1. Introduction	353
2. Reflection Model	358
3. Specular-to-diffuse mechanism	360
4. Separation Method	366
5. Implementation	370
6. Discussion	372
7. Experimental Results	374
8. Conclusion	375
Appendix: A	378
Appendix: B	378
Acknowledgments	381
References	382
18	
Creating Photorealistic Virtual Model with Polarization-based Vision System	385
<i>Takushi Shibata, Toru Takahashi, Daisuke Miyazaki, Yoichi Sato, Katsushi Ikeuchi</i>	

1.	Introduction	385
2.	Reflection Mechanism	388
3.	Polarization	392
4.	Data Acquisition System	394
5.	Separation of Reflection Components	395
6.	Parameter Estimation	397
7.	Synthesized Images	398
8.	Conclusion	398
	Acknowledgments	399
	References	399

Part IV Digitizing Cultural Heritage

19		
	Classification of Bayon Faces	405
	<i>Mawo Kamakura, Takeshi Oishi, Jun Takamatsu, and Katsushi Ikeuchi</i>	
1.	Introduction	405
2.	Bayon face	406
3.	Classification technique	408
4.	Experiments	413
5.	Conclusion	417
	Acknowledgments	417
	References	417
20		
	Illumination Simulation for Archaeological Investigation	419
	<i>Tomohito Masuda, Yosuke Yamada, Nobuaki Kuchitsu, and Katsushi Ikeuchi</i>	
1.	Introduction	419
2.	Related Work	420
3.	Acquisition of Geometric Information	421
4.	Acquisition of Photometric Information	422
5.	Fugoppe Cave	422
6.	Ozuka Tumulus	427
7.	Summary	430
	Acknowledgments	430
	References	430
21		
	Editing, Retrieval, and Display System of Archeological Information on Large 3D Geometric Models	441
	<i>Yasuhide Okamoto, Takeshi Oishi, and Katsushi Ikeuchi</i>	
1.	Introduction	442
2.	Overview of Proposed System	443
3.	Browsing	444
4.	Associating Information	446
5.	Experimental Result	450
6.	Conclusion	453
	Acknowledgments	453

<i>Contents</i>	xv
References	454
22	
Virtual Asukakyo: Real-time Soft Shadows in Mixed Reality using Shadowing Planes	457
<i>Tetsuya Kakuta, Takeshi Oishi, and Katsushi Ikeuchi</i>	
1. Introduction	457
2. Generation of Shadowing Planes and Basis Images	458
3. Real-Time Shadowing Process	463
4. Experimental Result	464
5. Virtual Asukakyo Project	466
6. Conclusion	469
References	470
23	
Digital Restoration of the Nara Great Buddha	473
<i>Takeshi Oishi and Katsushi Ikeuchi</i>	
1. Introduction	473
2. Toudaiji and the Great Buddha	474
3. Restoring the Buddha Statue	475
4. Restoring the Buddha Palace	476
5. Analysis	477
6. Conclusion	481
Acknowledgments	483
References	483
Part V Gallery	
References	497
Index	501



<http://www.springer.com/978-0-387-75806-0>

Digitally Archiving Cultural Objects

Ikeuchi, K.; Miyazaki, D. (Eds.)

2008, XXXIV, 504 p., Hardcover

ISBN: 978-0-387-75806-0