

Contents

- 1 Introduction 1**
 - 1.1 3D-Video Applications..... 2
 - 1.2 Requirements and Trends of 3D Multimedia 3
 - 1.3 Overview on Multimedia Embedded Systems 5
 - 1.4 Issues and Challenges..... 6
 - 1.5 Monograph Contribution..... 7
 - 1.5.1 3D-Neighborhood Correlation Analysis 7
 - 1.5.2 Energy-Efficient MVC Algorithms 8
 - 1.5.3 Energy-Efficient Hardware Architectures 9
 - 1.6 Monograph Outline 9
- 2 Background and Related Works 11**
 - 2.1 2D/3D Digital Videos..... 11
 - 2.2 Multiview Correlation Domains..... 14
 - 2.2.1 Spatial Domain Correlation..... 14
 - 2.2.2 Temporal Domain Correlation..... 15
 - 2.2.3 Disparity Domain Correlation 16
 - 2.3 Multiview Video Coding 16
 - 2.3.1 MVC Encoding Process 18
 - 2.3.2 Motion and Disparity Estimation 22
 - 2.3.3 MVC Mode Decision 27
 - 2.3.4 MVC Rate Control 28
 - 2.4 3D-Video Systems 29
 - 2.5 Multimedia Architectures Overview 30
 - 2.5.1 Multimedia Processors/DSPs 30
 - 2.5.2 Reconfigurable Processors for Video Processing..... 31
 - 2.5.3 Application-Specific Integrated Circuits 32
 - 2.5.4 Heterogeneous Multicore SoCs..... 33

2.6	Energy-Efficient Architectures for Multimedia Processing	33
2.6.1	Video Memories	34
2.6.2	SRAM Dynamic Voltage-Scaling Infrastructure.....	34
2.6.3	Dynamic Power Management for Memories.....	35
2.6.4	Energy Management for Multimedia Systems	36
2.6.5	Energy-Efficient Video Architectures	37
2.7	Energy/Power Consumption Background	38
2.8	Energy-Efficient Algorithms for Multiview Video Coding.....	40
2.8.1	Energy-Efficient Mode Decision	40
2.8.2	Energy-Efficient Motion and Disparity Estimation.....	42
2.9	Video Quality on Energy-Efficient Multiview Video Coding.....	45
2.9.1	Control Techniques Background	46
2.10	Summary of Background and Related Works	50
3	Multiview Video Coding Analysis for Energy and Quality.....	53
3.1	Energy Requirements for Multiview Video Coding.....	53
3.1.1	MVC Computational Effort.....	57
3.1.2	MVC Memory Access.....	59
3.1.3	Adaptivity in MVC Video Encoder	60
3.2	Energy-Related Challenges in Multiview Video Coding	62
3.3	Objective Quality Analysis for Multiview Video Coding	63
3.4	Quality-Related Challenges in Multiview Video Coding.....	65
3.5	Overview of Proposed Energy-Efficient Algorithms and Architectures for Multiview Video Coding	66
3.5.1	3D-Neighborhood.....	67
3.5.2	Energy-Efficient Algorithms	68
3.5.3	Energy-Efficient Architectures.....	69
3.6	Summary of Application Analysis for Energy and Quality	71
4	Energy-Efficient Algorithms for Multiview Video Coding.....	73
4.1	3D-Neighborhood Correlation Analysis	74
4.1.1	Coding Mode Correlation Analysis.....	74
4.1.2	Motion Correlation Analysis.....	82
4.1.3	Bitrate Correlation Analysis.....	84
4.2	Thresholds	87
4.3	Multilevel Mode Decision-based Complexity Adaptation	90
4.3.1	Multilevel Fast Mode Decision	90
4.3.2	Energy-Aware Complexity Adaptation	95
4.3.3	Multilevel Fast Mode Results.....	100
4.3.4	Energy-Aware Complexity Adaptation Results	105
4.4	Fast Motion and Disparity Estimation.....	107
4.4.1	Fast Motion and Disparity Estimation Algorithm.....	107
4.4.2	Fast ME/DE Algorithm Results	109

4.5	Video-Quality Management for Energy-Efficient Algorithms.....	111
4.5.1	Hierarchical Rate Control for MVC.....	111
4.5.2	Frame-Level Rate Control.....	113
4.5.3	Basic Unit-Level Rate Control.....	119
4.5.4	Hierarchical Rate Control Results.....	121
4.6	Summary of Energy-Efficient Algorithms for Multiview Video Coding.....	126
5	Energy-Efficient Architectures for Multiview Video Coding.....	127
5.1	Motion and Disparity Estimation Hardware Architecture.....	127
5.1.1	SAD Calculator.....	130
5.1.2	Programmable Search Control Unit.....	131
5.1.3	On-Chip Video Memory.....	133
5.1.4	Address Generation Unit.....	134
5.2	Parallelism in the MVC Encoder and ME/DE Scheduling.....	136
5.2.1	Parallelism in the MVC Encoder.....	136
5.2.2	ME/DE Hardware Architecture Pipeline Scheduling.....	137
5.3	Dynamic Search Window Formation.....	140
5.3.1	ME/DE Memory Access Pattern Analysis.....	140
5.3.2	Search Map Prediction.....	142
5.3.3	Dynamic Search Window Formation.....	143
5.4	On-Chip Video Memory.....	145
5.4.1	On-Chip Memory Design.....	145
5.4.2	Application-Aware Power Gating.....	146
5.5	Hardware Architecture Evaluation.....	148
5.5.1	Dynamic Window Formation Accuracy.....	148
5.5.2	Hardware Architecture Evaluation.....	148
5.6	Summary of Energy-Efficient Algorithms for Multiview Video Coding.....	150
6	Results and Comparison.....	151
6.1	Experimental Setup.....	151
6.1.1	Software Simulation Environment.....	151
6.1.2	Benchmark Video Sequences.....	152
6.1.3	Fairness of Comparison.....	155
6.1.4	Hardware Description and ASIC Synthesis.....	155
6.2	Comparison with the State of the Art.....	156
6.2.1	Energy-Efficient Algorithms.....	156
6.2.2	Video Quality Control Algorithms.....	161
6.2.3	Energy-Efficient Hardware Architectures.....	163
6.3	Summary of Results and Comparison.....	166

7 Conclusion and Future Works	169
7.1 Future Works	171
7.1.1 Remaining MVC Challenges	172
7.1.2 3D-Video Pre- and Post-processing	172
7.1.3 Next-Generation 3D-Video Coding.....	172
Appendix A: JMVC Simulation Environment	175
A.1 JMVC Encoder Overview	175
A.2 Modifications to the JMVC Encoder	178
A.2.1 JMVC Encoder Tracing	178
A.2.2 Communication Channels in JMVC	178
A.2.3 Mode Decision Modification in JMVC.....	179
A.2.4 ME/DE Modification in JMVC.....	179
A.2.5 Rate Control Modification in JMVC.....	179
Appendix B: Memory Access Analyzer Tool	181
B.1 Current Macroblock-Based Analysis	182
B.2 Search Window-Based Analysis	182
Appendix C: CES Video Analyzer Tool	185
References	189
Index	199

3D Video Coding for Embedded Devices
Energy Efficient Algorithms and Architectures
Zatt, B.; Shafique, M.; Bampi, S.; Henkel, J.
2013, XIX, 204 p. 126 illus., 112 illus. in color.,
Hardcover
ISBN: 978-1-4614-6758-8