

Contents

- 1 Introduction 1**
 - 1.1 Popular Video and Audio Standards 1
 - 1.2 Digital Representation of Video 3
 - 1.3 Basic Structure of Video Codec 18
 - 1.4 Performance Comparison Metrics for Video Codec 18
 - 1.5 Digital Representation of Audio 28
 - 1.6 Basic Structure of Perceptual Audio Coding 29
 - 1.7 Performance Comparison Metrics for Audio Codec 31
 - 1.8 Summary 36

- 2 Video Coding Standards and Video Formats 37**
 - 2.1 Introduction 37
 - 2.2 Complexity Reduction 40
 - 2.3 Video Coding Standards 40
 - 2.4 MPEG and H.26x 41
 - 2.4.1 H.120 41
 - 2.4.2 H.261 41
 - 2.4.3 MPEG-1 42
 - 2.4.4 H.262/MPEG-2 42
 - 2.4.5 H.263, H.263+ and H.263++ 43
 - 2.4.6 MPEG-4 43
 - 2.4.7 H.264/MPEG-4 Part 10/AVC 44
 - 2.4.8 H.265/HEVC 45
 - 2.5 Video Formats and Quality 45
 - 2.5.1 Frames and Fields 45
 - 2.5.2 Color Spaces 46
 - 2.5.3 Video Formats 49
 - 2.5.4 Quality 49
 - 2.6 Summary 50

3	AVS China	51
3.1	AVS China	51
3.2	AVS China Profiles and Levels	52
3.2.1	AVS-Video Jizhun (Base) Profile	52
3.2.2	AVS-Video Jiben (Basic) Profile	53
3.2.3	AVS-Video Shenzhan (Extended) Profile	53
3.2.4	AVS-Video Jiaqiang (Enhanced) Profile	55
3.3	Data Formats Used in AVS	55
3.3.1	AVS Video Layered Structure	56
3.4	AVS Video Encoder	59
3.4.1	Encoder Process Outline	60
3.4.2	Coding Tools Used in AVS Video Coder	61
3.5	AVS Video Decoder	69
3.6	AVS Video Bit Stream	69
3.6.1	Start Code	70
3.6.2	Start Code Value	70
3.6.3	Picture_coding_type	71
3.7	NAL Unit for AVS Video Stream	72
3.7.1	NAL Unit Mapping with AVS Video Stream	72
3.7.2	NAL Unit Header Description	72
3.8	Introduction to AVS-M (AVS Part 7)	74
3.8.1	Data Structure of AVS-M	75
3.8.2	Embodiment of AVS-M	78
3.8.3	Various Levels in Jiben Profile	80
3.9	Block Mode Prediction Modes	81
3.9.1	Intra Prediction	81
3.9.2	Inter Prediction	83
3.9.3	Skip Mode Prediction	84
3.9.4	RD Optimization	85
3.10	Transform, Quantization and Entropy Coding	85
3.10.1	Transform	85
3.10.2	Quantization	86
3.10.3	Entropy Coding	86
3.10.4	Simplified Deblocking Filter	87
3.11	AVS Part-1: System	89
3.11.1	Program Stream	91
3.11.2	Transport Stream	92
3.12	IEEE AVS	96
3.12.1	Applications	97
3.12.2	Profiles and Levels	97
3.12.3	Overview of the Design Characteristics	97
3.13	Summary	98
3.14	Projects	98

4	H.264/MPEG-4 Advanced Video Coding	99
4.1	Introduction	99
4.2	Profiles and Levels of H.264	100
4.2.1	Profiles in H.264	100
4.2.2	Levels in H.264	105
4.3	H.264 Encoder	105
4.4	Intra-Prediction	107
4.5	Inter-Prediction	108
4.6	Inter Prediction of Macroblocks in P-Slices	108
4.7	Sub-Pixel Motion Vectors	109
4.8	Transform and Quantization	112
4.9	In-Loop Deblocking Filter	112
4.9.1	Filter Strength	114
4.10	B-Slices and Adaptive Weighted Prediction	116
4.11	Entropy Coding	117
4.12	H.264 Decoder	119
4.13	Some Applications of H.264	120
4.14	Summary	121
4.15	Projects	121
5	High Efficiency Video Coding (HEVC)	125
5.1	Introduction	125
5.2	Joint Collaborative Team on Video Coding	125
5.3	Analysis of Coding Tools in HEVC Test Model, HM 1.0: Intra Prediction	132
5.4	HEVC Encoder	132
5.4.1	Intra Prediction	135
5.4.2	Transform Coefficient Scanning	136
5.4.3	Luma and Chroma Fractional Pixel Interpolation	137
5.4.4	Comparison of Coding Tools of HM1 and HEVC Draft 9	137
5.5	Extensions to HEVC	138
5.6	Profiles and Levels	140
5.7	Performance and Computational Complexity of HEVC Encoders	143
5.8	System Layer Integration of HEVC	144
5.9	HEVC Lossless Coding and Improvements	144
5.10	Summary	146
5.11	Projects	148
6	VP6 Video Coding Standard	159
6.1	Introduction	159
6.2	Comparison with Previous Flash Codec MX	160
6.3	VP6 Algorithm Fundamentals	165

6.4	Coding Profiles in VP6.	166
6.5	Types of Frames	167
6.5.1	Golden Frames	168
6.6	MB Modes	168
6.6.1	MB Modes in I-Frames (Intra-Mode)	168
6.6.2	MB Modes in P-Frames (Inter-Modes and Intra-Mode)	169
6.7	Nearest and Near Blocks.	170
6.8	Motion Vectors	171
6.8.1	Encoding.	172
6.8.2	Prediction Loop Filtering	172
6.9	Filtering for Fractional Pixel Motion Compensation.	172
6.9.1	Bilinear Filtering	173
6.9.2	Bicubic Filtering	173
6.10	Support for Unrestricted Motion Vectors	174
6.11	Prediction Loop Filtering	174
6.12	DCT, Scan Orders and Coefficient Token Set	174
6.12.1	Scan Orders.	180
6.12.2	DCT Coding and Coefficient Token Set	181
6.13	Quantization	186
6.14	Entropy Coding	187
6.14.1	Use of Context Information.	188
6.14.2	Huffman Coder	188
6.14.3	BoolCoder.	189
6.15	An Overview on VP6 Coding	189
6.16	Performance of VP6 Coding	190
6.17	VP6 Golden Frames	191
6.18	Background/Foreground Segmentation	191
6.19	Context Predictive Entropy Encoding.	192
6.20	Bitstream Partitions	192
6.21	Dual Mode Arithmetic and VLC Encoding	194
6.22	Adaptive Sub-Pixel Motion Estimation.	194
6.23	VP6-E and VP6-S Encoder Profiles	194
6.24	Device Ports and Hardware Implementations.	195
6.25	Summary	197
6.26	Projects.	197
7	Performance Analysis and Comparison of the Dirac Video Codec with H.264/MPEG-4, Part 10	199
7.1	Introduction.	199
7.2	Dirac Architecture	200
7.2.1	Dirac Encoder	200
7.2.2	Dirac Decoder	201
7.3	Stages of Encoding and Decoding in Dirac	202

7.3.1	Wavelet Transform.	202
7.3.2	Scaling and Quantization	204
7.3.3	Entropy Coding	205
7.3.4	Motion Estimation	206
7.3.5	Motion Compensation.	207
7.3.6	Decoder	208
7.4	Implementation	209
7.4.1	Code Structure Overview	209
7.4.2	Simplicity and Relative Speed of Encoding.	209
7.5	Results	211
7.5.1	Compression Ratio Test	211
7.5.2	SSIM Test.	213
7.5.3	PSNR Test	214
7.6	Conclusions.	217
7.7	Future Research.	218
7.8	Summary	218
7.9	Projects.	218
8	The VC-1 Video Coding.	221
8.1	The VC-1 Structure	221
8.2	Integer Transform Coding.	222
8.2.1	Inverse Transform	222
8.2.2	Forward Transform	224
8.3	Motion Estimation/Compensation.	226
8.3.1	Loop Filter	227
8.3.2	Complexity	228
8.3.3	Profiles and Levels.	229
8.4	The Simple Profile.	232
8.4.1	Bitstream Structure.	232
8.4.2	Baseline Intra-Frame Compression.	233
8.4.3	Variable-Size Transform Specifications	234
8.4.4	Overlapped Transform	236
8.4.5	4MV per MB.	238
8.4.6	Quarter-pel MC for Y.	240
8.5	The Main Profile	244
8.5.1	Quarter-pel MC for C_bC_r	244
8.5.2	Start Codes	244
8.5.3	Extended MV	246
8.5.4	Loop Filter	246
8.5.5	Dynamic Resolution Change	247
8.5.6	B Frames	249
8.5.7	Adaptive MB Quantization	250
8.5.8	Intensity Compensation.	253
8.5.9	Range Adjustment	254

8.6	The Advanced Profile.	254
8.6.1	Bitstream Structure.	254
8.6.2	Interlace	255
8.6.3	Sequence Level User Data	257
8.6.4	Entry Point Layer.	258
8.6.5	Display Metadata	258
8.7	The H.264 to VC-1 Transcoding	259
8.7.1	Intra MB Mode Mapping	260
8.7.2	Inter MB Mode Mapping	261
8.7.3	Motion Vector Mapping	262
8.7.4	Reference Pictures	263
8.7.5	Skipped MB	263
8.8	Transport of VC-1	263
8.8.1	Encapsulation of VC-1 in TS	265
8.8.2	Encapsulation of VC-1 in PS.	265
8.9	VC-2 Video Compression	267
8.9.1	Introduction.	267
8.9.2	Scope	268
8.10	Summary	269
8.11	Projects.	269
Appendix A: Investigation of Image Quality of Dirac, H.264 and H.265		271
A.1	Introduction.	271
A.2	H.265	271
A.3	Image Quality Assessment Using SSIM and FSIM.	272
A.4	Results	277
A.4.1	Results using Foreman QCIF Sequence	277
A.4.2	Results using Foreman CIF Sequence.	277
A.4.3	Results using container QCIF Sequence	277
A.4.4	Results using container CIF Sequence	277
A.5	Conclusions.	277
A.6	Projects.	294
Appendix B: PSNR Average for AVSNR Software		295
Appendix C: A Universal Image Quality Index and SSIM Comparison		297
C.1	Introduction.	297
C.2	Universal Image Quality Index [Q8].	302
C.3	Structural Similarity Index [Q13].	304
C.4	Images with Distortions [G11]	311
C.5	Results	315
C.6	Conclusions.	318

C.7	Project	319
C.8	JVT Document on Video Quality Metrics in the H.264 Reference Software	320

Appendix D: Implementation of Mode Dependent

	DCT/DST in H.264	325
D.1	Introduction.	325
D.2	Transform Implementation in the Reference Software	326
D.3	Proposed Scheme.	327
D.3.1	Mapping from Intra Prediction Modes to DCT/DST. . .	327
D.3.2	Obtaining DST Matrices for H.264	327
D.3.3	Implementation of DCT/DST in the Reference Software for H.264/AVC	329
D.4	Calculation of BD-PSNR and BD-Bit rate.	330
D.5	Performance Analysis.	331
D.5.1	Results for WQVGA (416×240) Sequences	331
D.5.2	Results for WVGA (832×480) Sequences.	332
D.5.3	Results for HD (1920×1080) Sequences.	332
D.5.4	Results for HD (1080×720) Sequences.	335
D.5.5	Results for different combinations of DCT/DST applied to RaceHorses Sequences.	335
D.6	Conclusions and Future Work	341

Appendix E: Performance Analysis and Comparison

	of JM, Intel IPP and X264 for H.264 Softwares	347
E.1	H.264	347
E.2	JM Software [H30]	349
E.3	X264 [X1]	349
E.4	Intel IPP [X3]	350
E.5	JM (17.2) Performance Analysis	351
E.6	X264 Performance Analysis	355
E.7	Intel IPP Performance Analysis	356
E.8	Comparison of SSIM for JM, X264 and Intel IPP Softwares in Baseline, Main and High Profiles.	360
E.9	Comparison of PSNR for JM, X264 and Intel IPP Softwares in Baseline, Main and High Profiles.	362
E.10	Comparison of Encoding Time for JM, X264 and Intel IPP Softwares in Baseline, Main and High Profiles	364
E.11	Comparison of Compression Ratio for JM, X264 and Intel IPP Softwares in Baseline, Main and High Profiles	366
E.12	Conclusions.	368
E.13	Future Work	368

Appendix F: Implementation of AIC Based on I-Frame Only Coding in H.264 and Comparison with Other Still Frame Image Coding Standards Such as JPEG, JPEG 2000, JPEG-LS and JPEG-XR 369

F.1 Introduction. 369

F.2 Advanced Image Coding. 370

F.3 Modified AIC 375

F.4 H.264 Standard 377

F.5 JPEG 380

F.6 JPEG2000 381

F.7 JPEG XR 383

F.8 JPEG-LS. 384

F.9 JPEG-LS Algorithm 385

F.10 Main Differences [AC1, H11, J22, JX3, JL2, JL4]. 387

F.11 Evaluation Methodology 388

F.12 Conclusions and Future Work 392

Appendix G: Higher Order 2-D ICTs for HD Video Coding. 421

G.1 Discrete Cosine Transform and Video Compression. 421

G.2 Integer Cosine Transforms 423

G.3 Simple 2-D Order 16 ICT. 425

G.4 Modified 2-D Order 16 ICT 429

G.5 2-D Order 16 binDCT Based on Loeffler’s Factorization 433

G.6 Transform Coding Gain 435

G.7 Implementation in H.264/AVC and Performance Analysis 437

G.8 Implementation in AVS Video and Performance Analysis. . . . 439

G.9 Conclusions and Future Work 442

Appendix H: Comparison of H.264 Codecs. 443

Bibliography 449

Index 479

Video coding standards

AVS China, H.264/MPEG-4 PART 10, HEVC, VP6, DIRAC
and VC-1

Rao, K.R.; Kim, D.N.; Hwang, J.J.

2014, XXIII, 499 p. 335 illus., Hardcover

ISBN: 978-94-007-6741-6