ISO/IEC 14496-16:2009-12 (E)

Information technology - Coding of audio-visual objects - Part 16: Animation Framework eXtension (AFX)

Contents

Page

Foreword vi

1 Scope 1

2 Normative references 1

3 Symbols and abbreviated terms 1
3.1 Introduction 2
3.2 The AFX place within computer animation framework 3
3.3 Geometry tools 5
3.3.1 Non-Uniform Rational B-Spline (NURBS) 5
3.3.2 Subdivision surfaces 8
3.3.3 MeshGrid representation 28
3.3.4 MorphSpace 34
3.3.5 MultiResolution FootPrint-Based Representation 35
3.3.6 Solid representation 39
3.4 Texture tools 49
3.4.1 Depth Image-Based Representation 49
3.4.2 Depth Image-based Representation Version 2 53
3.4.3 Multitexturing 57
3.5 Animation tools 62
3.5.1 Deformation tools 62
3.5.2 Generic skeleton, muscle and skin-based model definition and animation 64
3.6 Rendering tools 74
3.6.1 Shadows 74

4 AFX bitstream specification - 3D Graphics compression tools 76
4.1 Introduction 76
4.2 Geometry tools 77
4.2.1 3DMC Extension 77
4.2.2 Wavelet Subdivision Surfaces 134
4.2.3 MeshGrid stream 137
4.2.4 MultiResolution FootPrint-Based Representation 174
4.3 Texture tools 182
4.3.1 Depth Image-Based Representation 182
4.3.2 PointTexture stream 187
4.4 Animation tools 197
4.4.1 Bone-based animation 197
4.4.2 Frame-based Animated Mesh Compression (FAMC) stream 211
4.5 Generic tools 234
4.5.1 Multiplexing of 3D Compression Streams: the MPEG-4 3D Graphics stream (.m3d) syntax 234
4.5.2 AFX Generic Backchannel 238

5 AFX object codes 249

6 3D Graphics Profiles 250
6.1 Introduction 250
6.2 "Graphics" Dimension 251
6.2.1 MPEG-4 X3D Interactive Graphics Profiles and Levels 251
6.2.2 MPEG-4 "Basic AFX" Graphics Profiles and Levels 254

6.3 "Scene Graph" Dimension 256
6.3.1 MPEG-4 X3D Interactive Scene Graph Profile and Levels 256
6.3.2 PEG-4 "Basic AFX" Scene Graph Profile and Levels 259
6.4 "3D Compression" Dimension 261
6.4.1 "Core 3D Compression" Profile and Levels 262
6.4.2 3D Multiresolution Compression Profile and Levels 265

7 XMT representation for AFX tools 269
7.1 AFX nodes 269
7.2 AFX encoding hints 269
7.2.1 WaveletSubdivision encoding hints 269
7.2.2 MeshGrid encoding hints 269
7.2.3 OctreeImage encoding hints 270
7.2.4 PointTexture encoding hints 270
7.2.5 BBA encoding hints 270
7.3 AFX encoding parameters 270
7.3.1 WaveletSubdivisionEncodingParameters 270
7.3.2 MeshGridEncodingParameters 271
7.3.3 PointTextureEncodingParameters 272
7.3.4 BBAEncodingParameters 272
7.4 AFX decoder specific info 273
7.4.1 WaveletSubdivision decoder specific info 273
7.4.2 MeshGrid decoder specific info 273
7.5 XMT for Bone-based Animation 274
7.5.1 BBA 274
7.5.2 BBA_header 274
7.5.3 BBA_encoding 275
7.5.4 BBA_body 275
7.5.5 BBA_frame 275
7.5.6 BBA_frameMask 275
7.5.7 BoneMask 276
7.5.8 MuscleMask 277
7.5.9 MorphMask 277
7.5.10 BBA_frameValues 278

Annex A (normative) Wavelet Mesh Decoding Process 279

A.1 Overview 279
A.2 Base mesh 279
A.3 Definitions and notations 279
A.4 Bitplanes extraction 280
A.5 Zero-tree decoder 281
A.6 Synthesis filters and mesh reconstruction 281
A.7 Basis change 282

Annex B (normative) MeshGrid Representation 283

B.1 The hierarchical multi-resolution MeshGrid 283
B.1.1 Building MeshGrid multi-resolution levels 283
B.1.2 Relation between the resolution level of the mesh and the number of reference-surfaces 284
B.1.3 Relation between the resolution level of the grid and the number of reference-surfaces 284
B.1.4 Region Of Interest (ROI): Computation of the ROIs size and position 285
B.2 Scalability Modes 287
B.2.1 Scalability types 287
B.2.2 The mesh resolution scalability 288
B.2.3 The scalability in shape precision 288
B.2.4 The vertex position scalability 289
B.3 Animation Possibilities 290
B.3.1 Introduction 290
B.3.2 Vertex-based animation 290
B.3.3 Rippling effects, changing the offsets 291
B.3.4 Animation of the reference-grid points 291

Annex C (informative) MeshGrid representation 293

C.1 Representing Quadrilateral meshes in the MeshGrid format 293
C.2 IndexedFaceSet models represented by the MeshGrid format 294
C.3 Computation of the number of ROIs at the highest resolution level given an optimal ROI size 294

Annex D (informative) Solid representation 296

D.1 Overview 296
D.2 Solid Primitives 296
D.3 Arithmetics of Forms 297
D.3.1 Introduction 297
D.3.2 General Arithmetic Operators on Densities 298
D.3.3 Ternary Logic: The Kleene Operators 300
D.3.4 Densities Filtering 302

Annex E (informative) Face and Body animation: XMT compliant animation and encoding parameter file format 303

E.1 XSD for FAP file format 303
E.2 XSD for BAP file format 304
E.3 XSD for EPF 305

Annex F (normative) Local refinements for MultiResolution FootPrint-Based Representation 309

Annex G (informative) Partition Encoding for FAMC 311

Annex H (informative) Animation Weights Encoding for FAMC 312

Annex I (normative) Layered decomposition for FAMC 313

I.1 Obtaining the layered decomposition 313
I.2 Deriving layers Id[l], l>0 using decoded data and connectivity (layeredDecompositionIsEncoded equals 1) 314
I.3 Deriving layers Id[l], l>0 using only connectivity (default option, layeredDecompositionIsEncoded equals 0) 314
I.4 Deriving layer Id[0] 317
I.5 Mesh simplification 319

Annex J (normative) Reconstruction of values from decoded prediction errors with LD technique for FAMC 321

Annex K (normative) CABAC definitions, basic functions, and binarizations (as used for FAMC) ... 324

K.1 CABAC definitions 324
K.1.1 Definition of the term CabacContext 324
K.1.2 Definition of the term DecodingEnvironment 324
K.2 CABAC basic functions 324
K.2.1 Definition of the function cabac.biari_init_context(ctx, preCtxState) 324
K.2.2 Definition of the function cabac.arideco_start_decoding(dec_env) 324
K.2.3 Definition of the function cabac.biari_decode_symbol(dec_env, ctx) 325
K.2.4 Definition of the function cabac.biari_decode_symbol_eq_prob(dec_env) 327
K.2.5 Definition of the function cabac.biari_decode_final(dec_env) 328
K.3 CABAC binarization functionss 328
K.3.1 Definition of the function cabac.exp_golomb_decode_eq_prob(dec_env, k) 328
K.3.2 Definition of the function cabac.unary_exp_golomb_decode(dec_env, ctx, exp_start) .. 328

Annex L (normative) Node coding tables 330

L.1 Node Coding tables 330

L.2 Node Definition Type tables 330

Annex M (informative) Patent statements 331

Bibliography 332