

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	OctreelImage 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 $Id[I]$, $I>0$ using decoded data and connectivity (layeredDecompositionIsEncoded equals 1)	314
I.3 Deriving layers $Id[I]$, $I>0$ 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 <code>cabac.biari_init_context(ctx, preCtxState)</code>	324
K.2.2 Definition of the function <code>cabac.arideco_start_decoding(dec_env)</code>	324
K.2.3 Definition of the function <code>cabac.biari_decode_symbol(dec_env, ctx)</code>	325
K.2.4 Definition of the function <code>cabac.biari_decode_symbol_eq_prob(dec_env)</code>	327
K.2.5 Definition of the function <code>cabac.biari_decode_final(dec_env)</code>	328
K.3 CABAC binarization functions	328
K.3.1 Definition of the function <code>cabac.exp_golomb_decode_eq_prob(dec_env, k)</code>	328
K.3.2 Definition of the function <code>cabac.unary_exp_golomb_decode(dec_env, ctx, exp_start)</code>	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