CANDIDE-3
– AN UPDATED PARAMETERISED FACE

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Abstract

During the last decade, CANDIDE has been a popular face model in many research labs around the world. One reason has been that it is a very simple model, another that it is publically available. There are, however, drawbacks with the model, mostly due to its simplicity. Also, the emergence of the MPEG-4 standard for face animation has actualized the need of an update, making the model compatible with the facial animation and definition parameters (FAPs and FDPs) defined in MPEG-4.

This report documents an updated version of CANDIDE, fulfilling the demands set by MPEG-4 and being somewhat less crude. The relation between the CANDIDE entities (vertices, Action Units) and the MPEG-4 parameters are available in tables in the appendices.

1. Introduction

CANDIDE is a parameterised face mask specifically developed for model-based coding of human faces. Its low number of polygons (approximately 100) allows fast reconstruction with small computing power.

CANDIDE is controlled by global and local Action Units (AUs). The global ones correspond to rotations around three axes. The local Action Units control the mimics of the face so that different expressions can be obtained.

The concept of Action Units was first described more than 30 years ago by the Swedish researcher Carl-Herman Hjortsjö [6]. This work was later extended (by Paul Ekman and Wallace V. Friesen at the University of California Medical Center) to what is called FACS, the Facial Action Coding System [2].

The CANDIDE model was created by Mikael Rydfalk at Linköping University in 1987 [10]. This work was motivated by the first attempts to perform image compression through animation [3][4], later called model-based, object-based or semantic coding.

The CANDIDE model became known to a larger public through journal articles [5][7][8]. It is publically available and is now used by research groups around the world.

1.1. The earlier CANDIDE versions

The original CANDIDE, described in the report by Rydfalk [10], contained 75 vertices and 100 triangles. This version is rarely used.

The most widespread version, the de facto standard CANDIDE model, is a slighlty modified model with 79 vertices, 108 surfaces and 11 Action Units; see Figure 1 (top). This model was created by Mårten Strömberg while implementing the first CANDIDE software package (see below), and is here referred to as CANDIDE-1.

Later, Bill Welsh at British Telecom [11] created another version with 160 vertices and 238 triangles covering the entire frontal head (including hair and teeth) and the shoulders; see Figure 1 (bottom). This version, known as CAN-

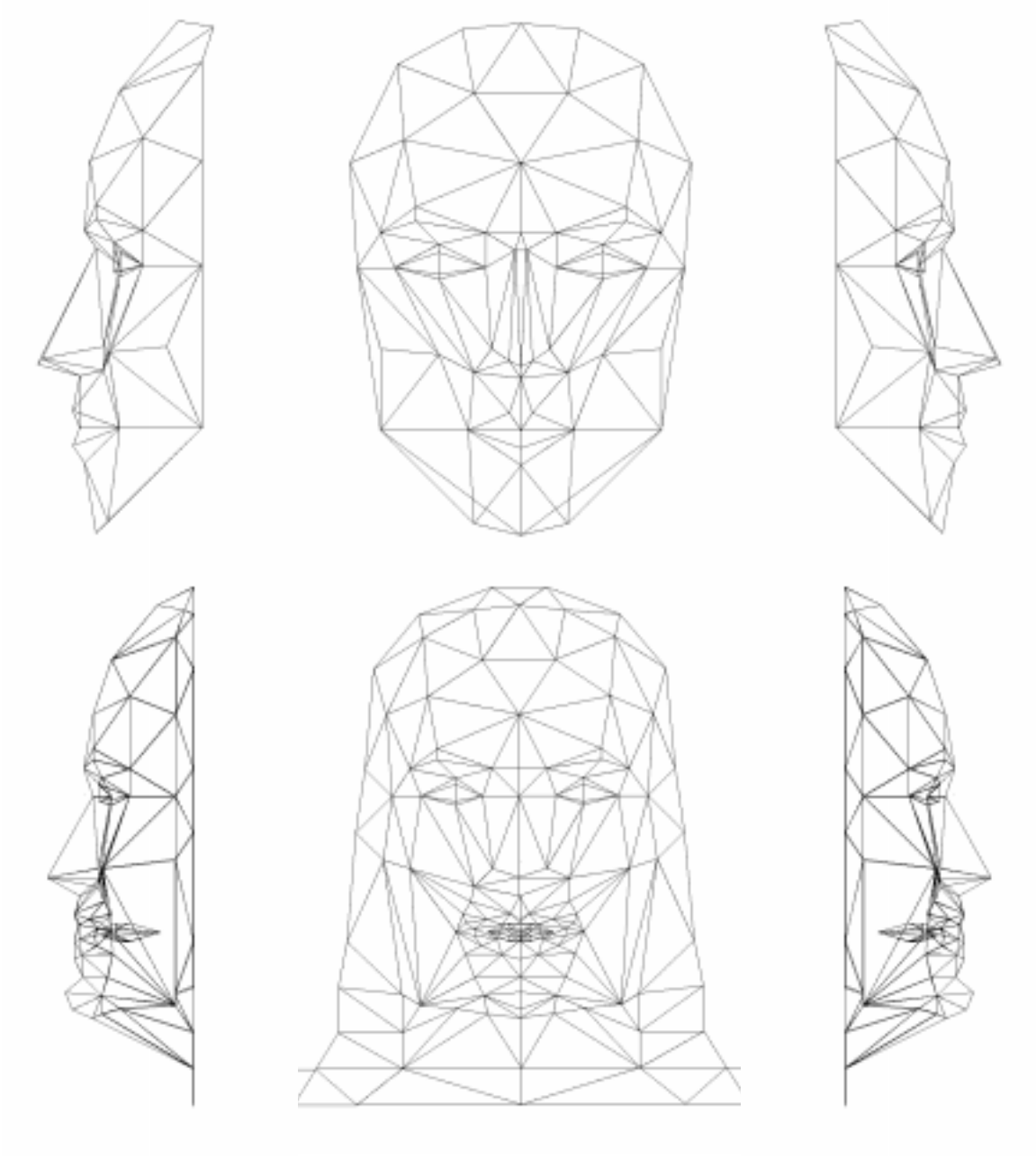

Figure 1. Top: CANDIDE-1 with 79 vertices and 108 surfaces. Bottom: CANDIDE-2 with 160 vertices and 238 surfaces.

DIDE-2 is also included in the CANDIDE software package, but is delivered with only six Action Units.

1.2. About this Report

This report partly replaces the original report by Rydfalk [10]. However, no detailed descriptions of the Action Units are found here (instead, see [2][6][10]). A future update may contain such descriptions.

Section 2 describes the changes in CANDIDE-3 (compared to CANDIDE-1), and Section 3 treats the parameterisation and control of wireframe face models. Section 4 describes the Action Units and Action Unit Vectors, and Section 5 the Shape Units (a new feature in CANDIDE-3). Section 6, finally, describes the relation between CANDIDE-3 and MPEG-4. The appendices contain tables defining Action Units, Action Unit Vectors, MPEG-4 facial feature points and CANDIDE vertices, and the file format for `wfm`-files.

Figure 2. Screenshots from the `xproject` software.

Figure 3. Screenshots from the `WinCandide` software.

1.3. Software

The first CANDIDE software package includes the definition (`wfm`) files for CANDIDE-1 and 2 together with C source code for a UNIX program called `xproject` (see Figure 2). There is also a software package called `WinCandide` for the PC/Windows platform (see Figure 3). This package handles CANDIDE-3 as well. Both software packages are available from the web site of the Image Coding Group at Linköping University (http://www.icg.isy.liu.se/candide).

2. News in CANDIDE-3

During the 90's, several advanced face models have been created by different research groups and companies, sometimes using thousands of polygons to describe a face, and sometimes with complex underlying physical and anatomical models. Despite this, the CANDIDE model is still widely used, since its simplicity makes it a good tool for image analysis tasks and low complexity animation. However, there have for some time been a need for an updated model, due to the following reasons:

- The very crude mouth and eyes makes the CANDIDE model very unrealistic. Adding only a few vertices would improve the quality significantly.
- A standard for which facial feature points should be used in face animation has been set in MPEG-4 [9]. Several of those facial feature points (FFPs) are missing among the vertices in the CANDIDE model.

Thus, the following changes have been made:

- The mouth has been modified to have vertices corresponding to inner and outer lip feature points, and vertices between the mouth corners and the lip centers have been added (vertices 79-89, MPEG-4 FFPs in group 2 and 8)
- The vertex on each cheek (vertex 27 and 60) have been replaced by two vertices corresponding to the FFPs 5.2 and 5.4 (right side) and 5.1 and 5.3 (left side). The new vertices have numbers 90 and 91.

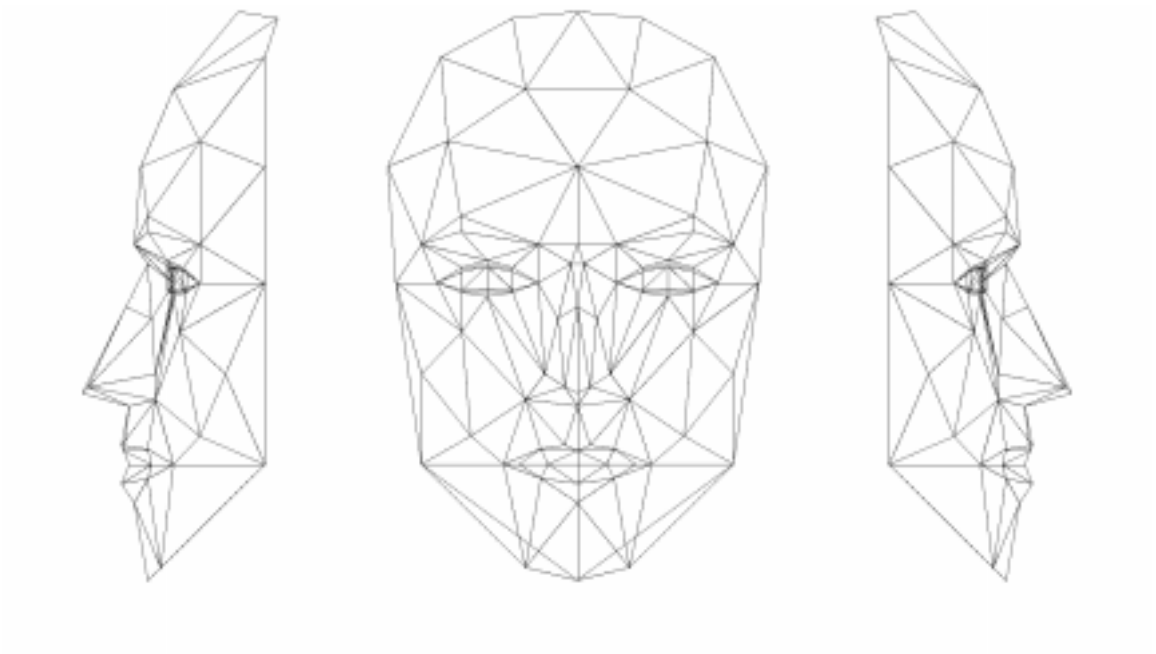

Figure 4. CANDIDE-3 with 113 vertices and 168 surfaces.

- Three vertices (92 - 94) on the middle of the nose, corresponding to FFPs 9.12, 9.13, and 9.14, have been added, and two vertices (111, 112) corresponding to FFPs 9.4 and 9.5 have been added.
- Vertices have been added to the eyes, making them less crude (vertices 95-110).
- The Action Units defined in CANDIDE-1 are extended to include the new vertices.
- Animation can be performed by MPEG-4 FAPs as well as by Action Units.

The resulting wireframe model is illustrated in Figure 4.

We make a distinction between Action Units and Animation Units. Action Units are the ones defined in FACS, while Animation Units is a more general term. Action Units and MPEG-4 FAPs (Facial Animation Parameters) are examples of Animation Units. The corresponding parameters are called Animation Parameters, and might be FAP values or Action Units Activation Levels.

Additionally, the functionality has been extended as well, by allowing Shape Units. A Shape Unit defines a deformation of a standard face towards a specific face. The Shape Parameters thus describes the static shape of a face, while the Animation Parameters describes the dynamic shape. Shape Parameters are invariant over time, but specific to each individual. Animation Parameters naturally varies over time, but can be used for animating different faces.

Other examples Shape Parameters are the FDP points in MPEG-4 and the Shape Modes of the Active Shape/Appearance Models in [1].

Also, the file format have been extended, allowing texture information, shape and animation parameters, shape units and global motion to be stored in the `wfm`-file. Naturally, full compatibility with earlier files are kept.

3. Controlling the Model

The model is a wireframe model with a texture mapped onto its surfaces. The vertex coordinates are stored in a `wfm`-file (the file format is doucmented in Appendix D), and can be seen as a $3N$-dimensional vector $\mathbf{g}$ (where N is the number of vertices) containing the (x, y, z) coordinates of the vertices.

The model is then reshaped according to

$$\mathbf{g}(\sigma, \alpha) = \bar{\mathbf{g}} + \mathbf{S}\sigma + \mathbf{A}\alpha \qquad (1)$$

where the resulting vector $\mathbf{g}$ contains the new (x, y, z) vertex coordinates. The columns of $\mathbf{S}$ and $\mathbf{A}$ are the Shape and Animation Units respectively, and thus the vectors σ and α contain the shape and animation parameters.

Since we also want to perform global motion, we need a few more parameters for rotation, scaling, and translation. Thus, we replace (1) with

$$\mathbf{g} = \mathbf{R}s(\bar{\mathbf{g}} + \mathbf{S}\sigma + \mathbf{A}\alpha) + \mathbf{t} \qquad (2)$$

where $\mathbf{R} = R(r_x, r_y, r_z)$ is a rotation matrix, s is the scale, and $\mathbf{t} = t(t_x, t_y, t_z)$ the translation vector.

The geometry of our model is thus parameterized by the parameter vector

$$\begin{aligned}\mathbf{p} &= [\nu, \sigma, \alpha] \qquad (3)\\ &= [r_x, r_y, r_z, s, t_x, t_y, t_z, \sigma, \alpha]\end{aligned}$$

where ν is the vector of global motion parameters. The file format supports having different scalings in the three dimensiones, i.e,

$$\mathbf{g} = \mathbf{R}\mathbf{S}_3(\bar{\mathbf{g}} + \mathbf{S}\sigma + \mathbf{A}\alpha) + \mathbf{t}, \qquad (4)$$

where $\mathbf{S}_3 = S_3(s_x, s_y, s_z)$.

The Animation Units can be implementations of the MPEG-4 FAPs or Action Unit Vectors implementing the Action Units from FACS.

4. The Action Units and Action Units Vectors

In earlier CANDIDE versions there is a slight confusion about Action Units (AUs) and Action Unit Vectors (AUVs). In the original report [10], the distinction is quite clear; an Action Unit is something that you do in your face with a (single) facial muscle activation, and an Action Unit Vector is the corresponding implementation (of one or more Action Units) in the CANDIDE model. For example, the Action Units 42 (Slit), 43 (Eyes Closed), 44 (Squint), and 45 (Blink) are all implemented by Action Unit Vector 6 – it is quite obvious that a quick blink with the eyes is a different action than closing the eyes, but it is also obvious that they should be implemented by the same Action Unit Vector.

So, what is then the confusion about? In the first CANDIDE software package (including the `wfm`-files for CANDIDE-1 and 2, and the `xproject` program), the AUVs are called Action Units, but use the numbering of the AUVs. Thus, in some cases this numbering has been used as the AU numbering. Further, the AUV numbering in CANDIDE-1 is not identical to the numbering in [10], and CANDIDE-2 contains yet a slightly different numbering.

In CANDIDE-3, the numbering from [10] is used. Listings of the Action Units and Action Units Vectors can be found in Appendix C.

The Action Unit Vectors are then generalized to Animation Units, since they also represent (for example) FAPs. Animation Units implemnting most of the MPEG-4 FAPs (see Section 6) are included in the definition file of CANDIDE-3.

5. The Shape Units

CANDIDE-3 is delivered with 12 Shape Units (SUs), making it possible to reshape CANDIDE to at least the most common head shapes. To allow a wider variation of head shapes, the user has to add more SUs, or to move vertices individually. The included SUs are listed in Table 1 below.

Table 1: The Shape Units

Shape Unit		Comment
0	Head height	Does not influence eyes, mouth, ...
1	Eyebrows, vertical position	
2	Eyes, vertical position	
3	Eyes, width	
4	Eyes, height	
5	Eye separation distance	
6	Cheeks z	z-extension of the cheek bone.
7	Nose z-extension	z-extension of the nose.
8	Nose vertical position	
9	Nose, pointing up	Vertical position of nose tip.
10	Mouth vertical position	
11	Mouth width	

6. Relation to MPEG-4 Face Animation

To make a face model compatible with MPEG-4 Face Animation, two things need to be determined: What FFPs correspond to which vertices, and the FAP units (FAPUs).

6.1. Vertices and FFPs

Most FFPs have their direct correspondance even in CANDIDE-1, and with the addition of vertex 89-112 almost all FFPs are represented. There are a few exceptions though:

- CANDIDE has no tongue, thus the FFPs in group 6 have no corresponding vertices.
- The entire head is not represented by CANDIDE, and thus the top of the spine (FFP 7.1) and the back of the skull (FFP 11.6) does not correspond to any vertices.
- CANDIDE-3 has (in contrast to CANDIDE-2) no teeth (FFPs 9.9 - 9.11).
- CANDIDE has no ears (FFPs 10.1 - 10.6).
- CANDIDE-3 has no hair, and thus no hair thickness (FFP 11.5).

All the FFPs and all the vertices are listed in Appendix A.

6.2. The FAP Units

The FAP units (FAPUs) are the units in which the motion of the feature points due to FAPs are measured. Except for the angular unit (AU), they are represented by 1024:ths of the FAPUs. For example, FAP 53 (*stretch_l_cornerlip_o*), moves FFP 8.3 to the left, and the corrsponding FAPU is MW (Motuh Width) [9]. Thus, setting FAP 53 to 256 would move FFP 8.3 256/1024 = 0.25 MW to the left.

In CANDIDE-3, that would mean moving vertex 31 (which, according to Appendix A, corresponds to FFP 8.3) to the left. The FAPU MW is calculated as the difference of the x-coordinates of vertex 31 and vertex 64 (see Table 2 below), when the face is in neutral position (as defined in [9]).

The FAPUs, and how they are defined in CANDIDE-3, are listed in Table 2. *rpupil* is the mean point of vertices 69, 70, 73, and 74. *lpupil* is the mean point of vertices 68, 69, 71, and 72. *pupil*.y is the mean of *lpupil*.y and *rpupil*.y.

Table 2: The FAP Units and CANDIDE

FAPU		CANDIDE
AU	Angular unit	1e-5 radians
MW	Mouth width	31.x - 64.x
MNS	Mouth-nose separation	6.y - 87.y
ENS	Eye-nose separation	*pupil*.y - 6.y
ES	Eye separation	*rpupil*.x - *lpupil*.x
IRISD	Iris diameter	73.y - 74.y

6.3. The FAPs

Most FAPs can be implemented in CANDIDE-3, but not all, since all FFPs do not have correspondances in CANDIDE-3. The FAPs not possible to implement are FAPs 43 - 47 (tongue) and FAPs 65 - 68 (ears). Also, FAPs 48 - 50 are not implemented as Animation Units, but as global parameters.

In the version of the CANDIDE-3 definition file (v3.1.3, as shown in Figure 4), FAPs 23 - 30 (eyeballs and pupils) are not implemented, since the iris-vertices have no surfaces. With a slightly different triangulation (available in CANDIDE 3.1.4), those FAPs have meaning. This increases the number of surfaces from 168 to 184.

Appendix A: The CANDIDE-3 Vertices and the Corresponding MPEG-4 Facial Feature Points

Vertex	Description	MPEG-4 FFP	
0	Top of skull	11	4
1	(Middle border between hair and forehead)	11	1
2	Middle of forehead		
3	Midpoint between eyebrows		
4	Not used (replaced by 77 and 78 in CANDIDE-1)		
5	Nose tip	9	3
6	Bottom middle edge of nose	9	15
7	Middle point of outer upper lip contour	8	1
8	Middle point of outer lower lip contour	8	2
9	Chin boss	2	10
10	Bottom of the chin	2	1
11	Left of top of skull		
12	Left of top of skull		
13	(Left border between hair and forehead)	11	3
14	Left side of skull		
15	Outer corner of left eyebrow	4	5
16	Uppermost point of the left eyebrow	4	3
17	Inner corner of left eyebrow	4	1
18	Lower contour of the left eyebrow, straight under 16		
19	Center of upper outer left eyelid	3	13
20	Outer corner of left eye	3	7
21	Center of upper inner left eyelid	3	1
22	Center of lower inner left eyelid	3	3
23	Inner corner of left eye	3	11
24	Center of lower outer left eyelid	3	9
25	Left nose border		
26	Left nostril outer border	9	1
27	Left cheek bone	5	3
28	Inner contact point between left ear and face	10	8
29	Upper contact point between left ear and face	10	9
30	Left corner of jaw bone	2	13
31	Left corner of outer lip contour	8	3
32	Chin left corner	2	11
33	Uppermost point of left outer lip contour	8	10
34	(Middle border between hair and forehead)	11	1
35	Not used (identical to 2)		
36	Not used (identical to 3)		
37	Not used (identical to 4)		
38	Not used (identical to 5)		

Vertex	Description	MPEG-4 FFP	
39	Not used (identical to 6)		
40	Middle point of inner lower lip contour	2	3
41	Not used (identical to 8)		
42	Not used (identical to 9)		
43	Not used (identical to 10)		
44	Right of top of skull		
45	Right of top of skull		
46	(Right border between hair and forehead)	11	2
47	Right side of skull		
48	Outer corner of right eyebrow	4	6
49	Uppermost point of the right eyebrow	4	4
50	Inner corner of right eyebrow	4	2
51	Lower contour of the right eyebrow, straight under 49		
52	Center of upper outer right eyelid	3	14
53	Outer corner of right eye	3	12
54	Center of upper inner right eyelid	3	2
55	Center of lower inner right eyelid	3	4
56	Inner corner of right eye	3	8
57	Center of lower outer right eyelid	3	10
58	Right nose border		
59	Right nostril border	9	2
60	Right cheek bone	5	4
61	Lower contact point between right ear and face	10	7
62	Upper contact point between right ear and face	10	10
63	Right corner of jaw bone	2	14
64	Right corner of outer lip contour	8	4
65	Chin right corner	2	12
66	Uppermost point of right outer lip contour	8	9
67	Left iris, outer upper corner of bounding (square) box		
68	Left iris, outer lower corner of bounding (square) box		
69	Right iris, outer upper corner of bounding (square) box		
70	Right iris, outer lower corner of bounding (square) box		
71	Left iris, inner upper corner of bounding (square) box		
72	Left iris, inner lower corner of bounding (square) box		
73	Right iris, inner upper corner of bounding (square) box		
74	Right iris, inner lower corner of bounding (square) box		
75	Left side of nose tip		
76	Right side of nose tip		
77	Left upper edge of nose bone	9	7
78	Right upper edge of nose bone	9	6
79	Midpoint between FFP 8.4 and 8.1 on outer upper lip contour	8	5

Vertex	Description	MPEG-4 FFP	
80	Midpoint between FFP 8.3 and 8.1 on outer upper lip contour	8	6
81	Midpoint between FFP 2.2 and 2.5 on the inner upper lip contour	2	6
82	Midpoint between FFP 2.2 and 2.4 on the inner upper lip contour	2	7
83	Midpoint between FFP 2.3 and 2.5 on the inner lower lip contour	2	8
84	Midpoint between FFP 2.3 and 2.4 on the inner lower lip contour	2	9
85	Midpoint between FFP 8.4 and 8.2 on outer lower lip contour	8	7
86	Midpoint between FFP 8.3 and 8.2 on outer lower lip contour	8	8
87	Middle point of inner upper lip contour	2	2
88	Left corner of inner lip contour	2	4
89	Right corner of inner lip contour	2	5
90	Center of the left cheek	5	1
91	Center of the right cheek	5	2
92	Left lower edge of nose bone	9	13
93	Right lower edge of nose bone	9	14
94	Middle lower edge of nose bone (or nose bump)	9	12
95	Outer upper edge of left upper eyelid		
96	Outer upper edge of right upper eyelid		
97	Outer lower edge of left upper eyelid		
98	Outer lower edge of right upper eyelid		
99	Outer upper edge of left lower eyelid		
100	Outer upper edge of right lower eyelid		
101	Outer lower edge of left lower eyelid		
102	Outer lower edge of right lower eyelid		
103	Inner upper edge of left upper eyelid		
104	Inner upper edge of right upper eyelid		
105	Inner lower edge of left upper eyelid		
106	Inner lower edge of right upper eyelid		
107	Inner upper edge of left lower eyelid		
108	Inner upper edge of right lower eyelid		
109	Inner lower edge of left lower eyelid		
110	Inner lower edge of right lower eyelid		
111	Bottom left edge of nose	9	5
112	Bottom right edge of nose	9	4

Appendix B: The MPEG-4 Facial Feature Points and the Corresponding CANDIDE-3 Vertices

MPEG-4 FFP		Description	Vertex
2	1	Bottom of the chin	10
	2	Middle point of inner upper lip contour	87
	3	Middle point of inner lower lip contour	40
	4	Left corner of inner lip contour	88
	5	Right corner of inner lip contour	89
	6	Midpoint between FFP 2.2 and 2.5 on the inner upper lip contour	81
	7	Midpoint between FFP 2.2 and 2.4 on the inner upper lip contour	82
	8	Midpoint between FFP 2.3 and 2.5 on the inner lower lip contour	83
	9	Midpoint between FFP 2.3 and 2.4 on the inner lower lip contour	84
	10	Chin boss	9
	11	Chin left corner	32
	12	Chin right corner	65
	13	Left corner of jaw bone	30
	14	Right corner of jaw bone	63
3	1	Center of upper inner left eyelid	21
	2	Center of upper inner right eyelid	54
	3	Center of lower inner left eyelid	22
	4	Center of lower inner right eyelid	55
	5	Center of the pupil of left eye	67/68/71/72
	6	Center of the pupil of right eye	69/70/73/74
	7	Outer corner of left eye	20
	8	Inner corner of right eye	56
	9	Center of lower outer left eyelid	24
	10	Center of lower outer right eyelid	57
	11	Inner corner of left eye	23
	12	Outer corner of right eye	53
	13	Center of upper outer left eyelid	19
	14	Center of upper outer right eyelid	52
4	1	Inner corner of left eyebrow	17
	2	Inner corner of right eyebrow	50
	3	Uppermost point of the left eyebrow	16
	4	Uppermost point of the right eyebrow	49
	5	Outer corner of left eyebrow	15
	6	Outer corner of right eyebrow	48
5	1	Center of the left cheek	90
	2	Center of the right cheek	91

MPEG-4 FFP		Description	Vertex
	3	Left cheek bone	27
	4	Right cheek bone	60
6	1-4	Tongue	n/a
7	1	Top of spine (center of rotation)	n/a
8	1	Middle point of outer upper lip contour	7
	2	Middle point of outer lower lip contour	8
	3	Left corner of outer lip contour	31
	4	Right corner of outer lip contour	64
	5	Midpoint between FFP 8.4 and 8.1 on outer upper lip contour	79
	6	Midpoint between FFP 8.3 and 8.1 on outer upper lip contour	80
	7	Midpoint between FFP 8.4 and 8.2 on outer lower lip contour	85
	8	Midpoint between FFP 8.3 and 8.2 on outer lower lip contour	86
	9	Uppermost point of right outer lip contour	66
	10	Uppermost point of left outer lip contour	33
9	1	Left nostril outer border	26
	2	Right nostril border	59
	3	Nose tip	5
	4	Bottom right edge of nose	112
	5	Bottom left edge of nose	111
	6	Right upper edge of nose bone	78
	7	Left upper edge of nose bone	77
	9-11	Teeth	n/a
	12	Middle lower edge of nose bone (or nose bump)	94
	13	Left lower edge of nose bone	92
	14	Right lower edge of nose bone	93
	15	Bottom middle edge of nose	6
10	1-6	Ears	n/a
	7	Lower contact point between right ear and face	61
	8	Inner contact point between left ear and face	28
	9	Upper contact point between left ear and face	29
	10	Upper contact point between right ear and face	62
11	1	(Border between hair and forehead)	1/34
	2	(Right border between hair and forehead)	46
	3	(Left border between hair and forehead)	13
	4	Top of skull	0
	5	Hair thickness over FFP 11.4	n/a
	6	Back of skull	n/a

Appendix C: Action Units and Action Unit Vectors

Action Unit numbering and naming from FACS [2].
Action Unit Vector (AUV) numbering from the original CANDIDE [10].

Action Unit	Name	AUV
Upper face Action Units		
1	Inner brow raiser	12
2	Outer brow raiser	5
4	Brow lowerer	3
5	Upper lid raiser	10
6	Cheek raiser and lid compressor	
7	Lid tightener	7
41	Lid drop	14
42	Slit	6
43	Eyes closed	6
44	Squint	6
45	Blink	6
46R	Wink (right)	17
46L	Wink (left)	19
Lower face up/down Action Units		
9	Nose wrinkler	8
10	Upper lip raiser	0
15	Lip corner depressor	14
17	Chin raiser	20
25	Lips part	
26	Jaw drop	11
27	Mouth stretch	11
16+25	Lower lip depressor	1
Lower face horizontal and oblique Action Units		
11	Nasolobial furrow deepener	
12	Lip corner pull	4
13	Sharp lip puller	14
14	Dimpler	
20	Lip stretcher	2
Lower face orbital Action Units		
18	Lip pucker	16
22+25	Lip funnler	
23	Lip tightener	9
24	Lip presser	9
28	Lip suck	

The columns C1, C2, and C3 tell what numbering the Action Unit / Action Unit Vector has in CANDIDE-1/2/3 respectively.					
AUV	AU	Name	C1	C2	C3
0	10	Upper lip raiser	0	0	0
1	16+25	Lower lip depressor			
2	20	Lip stretcher	2	2	2
3	4	Brow lowerer	3	3	3
4	12	Lip corner pull			
5	2	Outer brow raiser	5		5
6	42	Slit			
6	43	Eyes closed	6	3	6
6	44	Squint			
6	45	Blink			
7	7	Lid tightener	7		7
8	9	Nose wrinkler	8		8
9	23	Lip tightener			
9	24	Lip presser	9		9
10	5	Upper lid raiser	10		10
11	26	Jaw drop	1	1	11
	27	Mouth stretch			
12	1	Inner brow raiser		5	
13	41	Lid drop			
14	13	Sharp lip puller			
14	15	Lip corner depressor	4	4	14
15					
16	18	Lip pucker			
17	46R	Wink (right)			
19	46L	Wink (left)			
20	17	Chin raiser			

Appendix D: File format

This appendix documents the file format for wireframe (`wfm`) files. The file format is an extension of the file format used by `xproject` for CANDIDE-1 and 2. The difference is the inclusion of Animation Parameter values (Action Unit activation levels), Shape Units, Shape Parameter values, texture information and global motion.

File content	Description
# Candide-3	Name of the model (optional).
# Filename: candide3.wfm	Name of the file (optional).
# Fileversion: 2.1	Version of the file (optional).
# VERTEX LIST:	Optional comment.
<int **NoVertices**>	The number of vertices.
for V = 0 to NoVertices-1	
<float **x**> <float **y**> <float **z**>	x-, y-, z-coordinate of vertex no. V.
end	
# FACE LIST:	Optional comment.
<int **NoFaces**>	The no. of faces.
for F = 0 to NoFaces-1	
<int **V0**> <int **V1**> <int **V2**>	Face no. F is a triangle connecting vertices V0, V1, V2.
end	
# ANIMATION UNITS LIST:	Optional comment.
<int **NoAUs**>	The no. of Animation Units.
for AU = 0 to NoAUs-1	
# <string **AUName**>	Name of Animation Unit no. AU (optional).
# <string **FAPU**>	If the AU is a FAP, tell what FAPU to use (optional).
<int **NoVertices**>	No. of vertices affected by Animation Unit no. AU
for V= 0 to NoVertices-1	
<int **V**> <float **x**> <float **y**> <float **z**>	Vertex V is displaced (x, y, z) by Animation Unit no. AU.
end	
end	
# SHAPE UNITS LIST:	Optional comment.
<int **NoSUs**>	The no. of Shape Units.
for SU = 0 to NoSUs-1	
# <string **SUName**>	Name of Shape Unit no. SU (optional).
<int **NoVertices**>	No. of vertices affected by Shape Unit no. SU
for V= 0 to NoVertices-1	
<int **V**> <float **x**> <float **y**> <float **z**>	Vertex V is displaced (x, y, z) by Shape Unit no. SU.
end	
end	
# ANIMATION PARAMETERS:	Optional comment.
<int **NoAPs**>	The no. of Animation Parameter values.
for i = 0 to NoAPs-1	
<int **AP**> <float APval>	Animation Parameter no. AP has the value APval.

File content	Description
end	
# SHAPE PARAMETERS:	Optional comment.
<int **NoSPs**>	The no. of Shape Parameter values.
for i = 0 to NoSPs-1	
<int **SP**> <float **SPval**>	Shape Parameter no. SP has the value SPval.
end	
# TEXTURE:	Optional comment.
<int **NoTexCoords**>	The no. of texture coordinates given.
for i = 0 to NoTexCoords	
<int **V**> <float **x**> <float **y**>	Vertex V has texture coordinate (x, y).
end	
if NoTexCoords > 0	
<string **TextureFileName**>	The name of the file in which the texture is stored.
end	
# GLOBAL MOTION:	Optional comment.
<float **Rx**> <float **Ry**> <float **Rz**>	Rotation.
<float **Sx**> <float **Sy**> <float **Sz**>	Scale.
<float **Tx**> <float **Ty**> <float **Tz**>	Translation.
# END OF FILE	Optional comment.

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