ASUS V1/V2 Codecs

March 12, 2016

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1 Introduction

ASV1/2 are purely intracoded DCT-based codecs, with a per file quantization parameter (QP), use 4:2:0 YCbCr colorspace and operate on macroblocks.
The latest version of this document is available at http://www.mplayerhq.hu/~michael/asv1.{lyx,txt,html,ps}

This document assumes familiarity with mathematical and coding concepts such as the discrete cosine transform, quantization, YUV (YCbCr) colorspaces, macroblocks, and variable length codes (VLCs).

2 Terms and definitions

AC Any DCT coefficient for which the frequency in one or both both dimensions in non-zero.

DC The DCT coefficient for which the frequency is zero in both dimensions

QP Quantization Parameter

(I)DCT (Inverse) Discrete Cosine Transform

VLC Variable Length Code

3 Highlevel Description

3.1 Picture

The picture is split into macroblocks which are coded left->right, top->bottom, as long as MBs are completely within the width/height area that is divisible by 16. If width is not divisible by 16, the right column is coded after the main body. If height is not divisible by 16, the bottom strip is coded after the right column.

Example: 56x56 sized image

0	1	2	9
3	4	5	10
6	7	8	11
12	13	14	15

3.2 Macroblock

16x16 luma + 8x8 chroma as 4 8x8 luma blocks and 2 8x8 chroma blocks

Y:

0	1
2	3

Cb:

4

Cr:

5

3.3 Block

Contains 64(=8x8) coefficients in 16(=4x4) coefficient groups with 4(=2x2) coefficients each

0	1	5	9
2	3	8	12
4	7	11	14
6	10	13	15

Coefficients in the coefficient groups 10..15 cannot be coded (they must be 0) in ASV1.
The first coefficient (DC coefficient) in the first coefficient group must be coded as 0. Note it is coded seperately in the 8 bits prior to the AC coefficients.

3.4 Coefficient group

0	1
2	3

3.5 DC coefficient Dequantization

$c'_{00} = 8c_{00}$

c_{00}	quantized and coded DC coefficient
c'_{00}	unquantized DC coefficient

3.6 AC coefficient Dequantization

$c'_{xy} = \frac{c_{xy}}{16} \left\lfloor \frac{Dq_{xy}}{QP} \right\rfloor$

QP	Quantization Parameter from the global header
D	64 for ASV1, 128 forASV2
c	quantized and coded coefficient
c'	unquantized coefficient
q	ISO MPEG1 intra quantization matrix

4 Bitstream

The bitstream in ASV1 is stored with byte-swapped 32bit words (24..31, 16..23, 8..15, 0..7, 56..63, 48..55, 40..47, 32..39, ...)

The bitstream in ASV2 is stored with the bits in each byte reversed so (7..0, 15..8, 23..16, 31..24, 39..32, ...)

4.1 Fourcc

ASV1 / ASV2

4.2 Global (per file) Header

Length in bits	Value
8	QP
24	unkown, 0 for ASV1
8	'A'
8	'S'
8	'U'
8	'S'

Note, the biSize parameter (in the case of storage in AVI) is 48

4.3 Macroblock

Simply the bitstream of the 6 blocks

4.4 ASV1 Block

8-bit DC coefficient

. for each coefficient group

2-5bit Coded coefficient pattern
. for each coded coefficient
2-11bit level

5bit End Of Block

4.5 ASV2 Block

4-bit coefficient group count

8-bit DC coefficient

2-4bit First Coded coefficient pattern

. for each coded coefficient

2-13bit level

. for each coefficient group

2-6bit Coded coefficient pattern
. for each coded coefficient
2-13bit level

5 VLC Codes

5.1 ASV1

5.1.1 Level

0011	-3
011	-2
11	-1
000xxxxxxxx	xxxxxxxx
10	1
010	2
0010	3

xxxxxxxx is a twos complement signed 8 bit nubmer (=int8_t)

5.1.2 Coded coefficient pattern

00001	14
00010	13
...	...
01101	2
01110	1
01111	EOB
10	0
11	15

5.2 ASV2

5.2.1 First Coded coefficient pattern

VLC	CCP
00	0111
01	0000
100	0110
101	0100
1100	0011
1101	0001
1110	0101
1111	0010

5.2.2 Coded coefficient pattern

VLC	CCP
00	0000
010	0100
011	1000
1000	1010
1001	1100
1010	0010
1011	1101
1100	1111
1101	1110
111000	0111
111001	0101
111010	0011
111011	0001
111100	0110
111101	1001
11111	1011

5.2.3 Level

0000111111	-31
...	...
001111	-7
001011	-6
001101	-5
001001	-4
0111	-3
0101	-2
11	-1
00000xxxxxxxx	xxxxxxxx
10	1
0100	2
0110	3
001000	4
001100	5
001010	6
001110	7
...	...
0000111110	31

xxxxxxxx is a twos complement signed 8 bit nubmer (=int8_t)

6 Example ASV1 decoder

- foreach macroblock, decode Y0 Y1 Y2 Y3 U V blocks, Y blocks are arranged as:
  Y0 Y1
  Y2 Y3
- foreach block:
  - DC coeff is the next 8 bits in the stream * 8 (this gives a range of 0..2040)
  - foreach of up to 11 coefficient groups:
    - get vlc from ccp table, value should range from 0..16
    - if value is 16, coefficient decode is done
    - if 11th iteration, 16 should occur, else error
    - ccp contains 4 bits at this point (3-0)
    - each bit corresponds to a quantized coeff. #(iter. * 4 + bit)
    - if 0, coeff. is 0 else get_level():
      - get vlc from level vlc table
      - if vlc is 3, use the next 8 bits (as a signed number) as level
      - else, use vlc - 3
      - store coefficient
  - dequantize, idct

7 Changelog

0.01 2003-05-21
initial version by Michael Niedermayer with some stuff from Mike Melanson

0.02 2003-05-21
spelling, punctuation, example decoder, various minor changes by Mike Melanson
various minor changes by Michael

0.03 2003-09-01
minor fixes and ASV2 by Michael

0.04 2004-08-24
clarify bitstream order by Michael

0.05 2016-03-12
Add biSize value used in avi

8 Copyright