

SOURCE : JAPAN
TITLE : OPTIMIZATION OF 2-D VLC FOR SCIF CODING
Purpose: Information

1. Introduction

AVC-79 for the Santa Clara meeting provided simulation results on coding CCIR-601 signals through a progressive scan SCIF that had been proposed in AVC-29. The followings were observed;

- If the SCIF is used as the source coder input (SCIF mode), 2.4 times larger number of pels must be coded compared to the case that local interlaced video signals are directly coded (422 mode). Increase of coded bits is 25-30% for INTER and 35-40% for INTRA to obtain the same SNR values. If coding loss due to format conversion is discounted, inherent loss due to the pel number increase is estimated as 12% for INTER and 18% INTRA.
- The format conversion method used to obtain "576/60 progressive" from "480/60 interlaced" requires prediction based on 1/30 second previous signal as well as 1/60 second previous signal.
- Statistics on number of non-zero coefficients and zero coefficients per significant block are different among INTER/INTRA blocks and 422/SCIF modes, suggesting that SCIF coding efficiency may be improved by VLC optimization.

This document reports some experimental results intended to clarify possibilities of coding efficiency improvements through optimizing 2-d VLCs.

2. Design of 2-d VLC

2.1 Base statistics

Open loop coding with step size 10 has been carried out for 300 SCIF frames of each of four test sequences (Flower Garden, Mobile & Calendar, Table Tennis, Football) to obtain histograms on the event (LEVEL of non-zero coefficient, RUN of preceding zero coefficients).

For INTRA pictures, statistics of other three test sequences (Popple, Tempete, Susie) have also been taken.

2.2 Huffman coding

In addition to the table "vlc-422" used in the previous experiments, the following tables are designed according to the Huffman algorithm;

vlc-scif-fmtf	obtained from 1200 SCIF frames of four test sequences
vlc-scif-f	obtained from 300 SCIF frames of Flower Garden
vlc-scif-m	obtained from 300 SCIF frames of Mobile & Calendar
vlc-scif-intra	obtained from the first frames of 7 SCIF test sequences

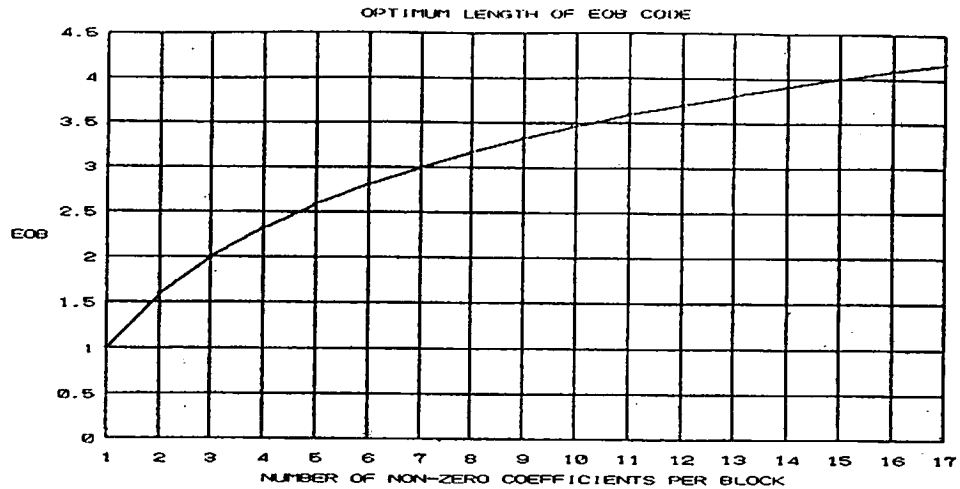


Figure 1 Optimum EOB code length

2.3 EOB code length

Optimum number of EOB bits is determined by the number of non-zero coefficients per block as shown in Figure 1. Since actual number of non-zero coefficients per significant block is 3-8 as shown in AVC-79, allocation of 3 bit word for EOB is appropriate.

In this experiments, tables of 2 bit EOB and 4 bit EOB are also tried.

2.4 Code tables

Four 2-d VLC tables are shown in Annex as examples.

3. Simulation experiments

3.1 Method of experiments

SCIF test sequences converted from CCIR-601 ones are fed to the source coder with different 2-d VLC tables, and the number of coded bits for the first 20 frames are measured. For INTRA coding performance, only the first frame of each SCIF test sequence is measured.

Coding algorithm is the one used at the previous experiment; hybrid coding with motion compensation referring to the two previous frames (1/60 second apart and 1/30 second apart).

3.2 Results for INTER mode

Total number of bits per SCIF frame (kbits per 1/60 sec) averaged over 19 coded frames have been measured as shown in Table 1 for different VLC tables.

It should be noted that these values include overhead bits (macroblock type, macroblock address, motion vectors) as well as DCT coefficient bits, and that the coded area is limited to the center 5/6 part of the original pictures.

Table 1 Number of coded bits per 1/60 second SCIF frame

Flower Garden

step size	sig coeff	vlc-422	vlc-scif-fmtf				vlc-scif-f		
		eob=3	eob=2	eob=3	eob=4		eob=2	eob=3	eob=4
8	5.62	276	275	274	277		274	273	276
10	4.64	214	212	212	215		211	211	214
12	3.99	173	170	172	175		170	171	174
14	3.52	144	142	144	147		141	143	146
16	3.16	124	121	123	126		121	122	125
18	2.88	109	106	108	110		105	107	110
20	2.66	96.7	93.9	95.9	98.4		93.6	95.3	97.9

Mobile and Calendar

step size	sig coeff	vlc-422	vlc-scif-fmtf				vlc-scif-m
		eob=3	eob=2	eob=3	eob=4		eob=3
8	9.00	514	519	509	510		505
10	7.90	406	409	403	404		401
12	7.06	333	335	331	333		330
14	6.39	280	280	278	281		279
16	5.83	240	240	239	241		240
18	5.32	210	209	209	211		210
20	4.89	185	183	184	186		185

Bit consumption at SNR=35dB is shown in Figure 2 for Flower Garden and Mobile & Calendar. It is known that overhead bits do not depend much on the quantizer step size. DCT coefficients and EOB dominate the bit consumption at this quality level.

Coding efficiency improvement by using optimized VLCs is found as less than 1%.

Compared to the 422 mode coding, information increase for the SCIF mode coding is shown in Figure 3. All the four elements are equally contributing to the information increase in Flower Garden, while DCT coefficients are dominant in Mobile & Calendar.

3.3 Results for INTRA mode

Rate distortion curves are shown in Figure 4. Dotted lines show the results obtained by using vlc-scif-intra which has been optimized for INTRA. As shown in the INTRA table/Annex, the short length code area spreads in the level direction and shrinks in the run direction compared to INTER tables.

Coding efficiency improvement is found as 7% for Flower Garden and 10% for Mobile & Calendar.

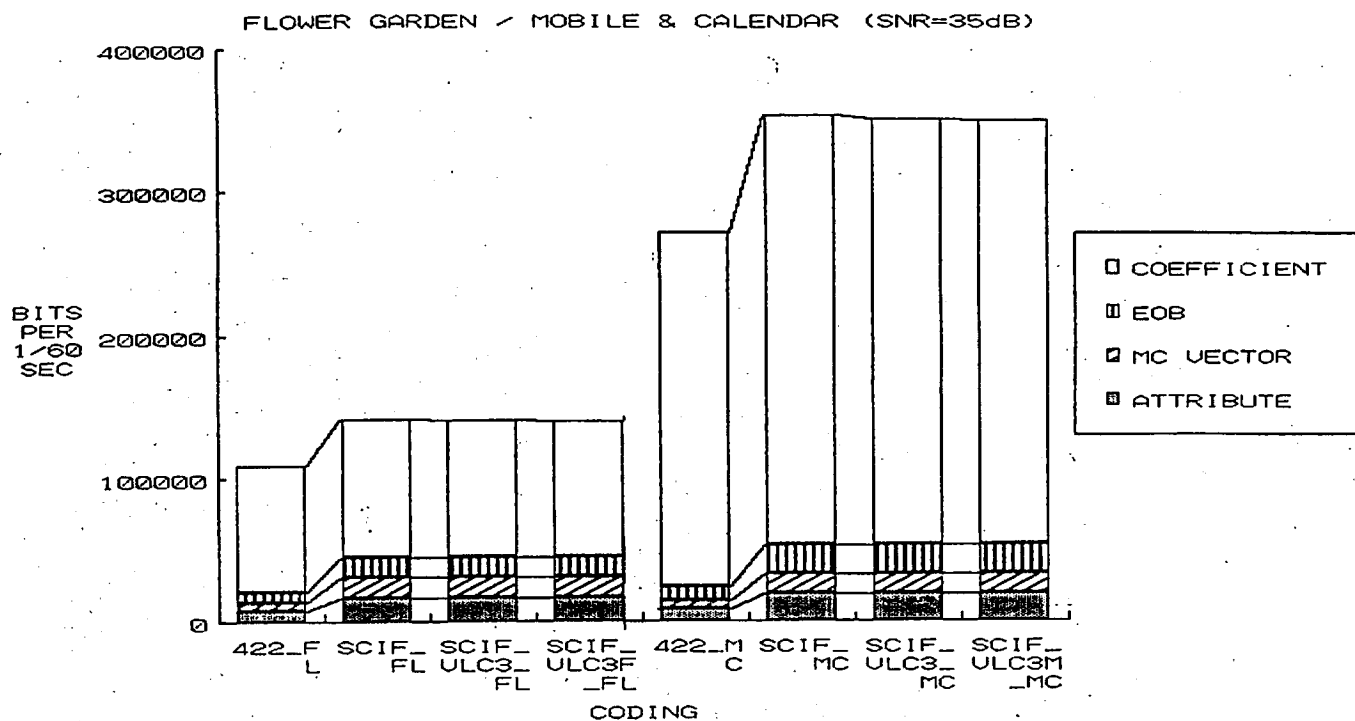


Figure 2 Bit consumption

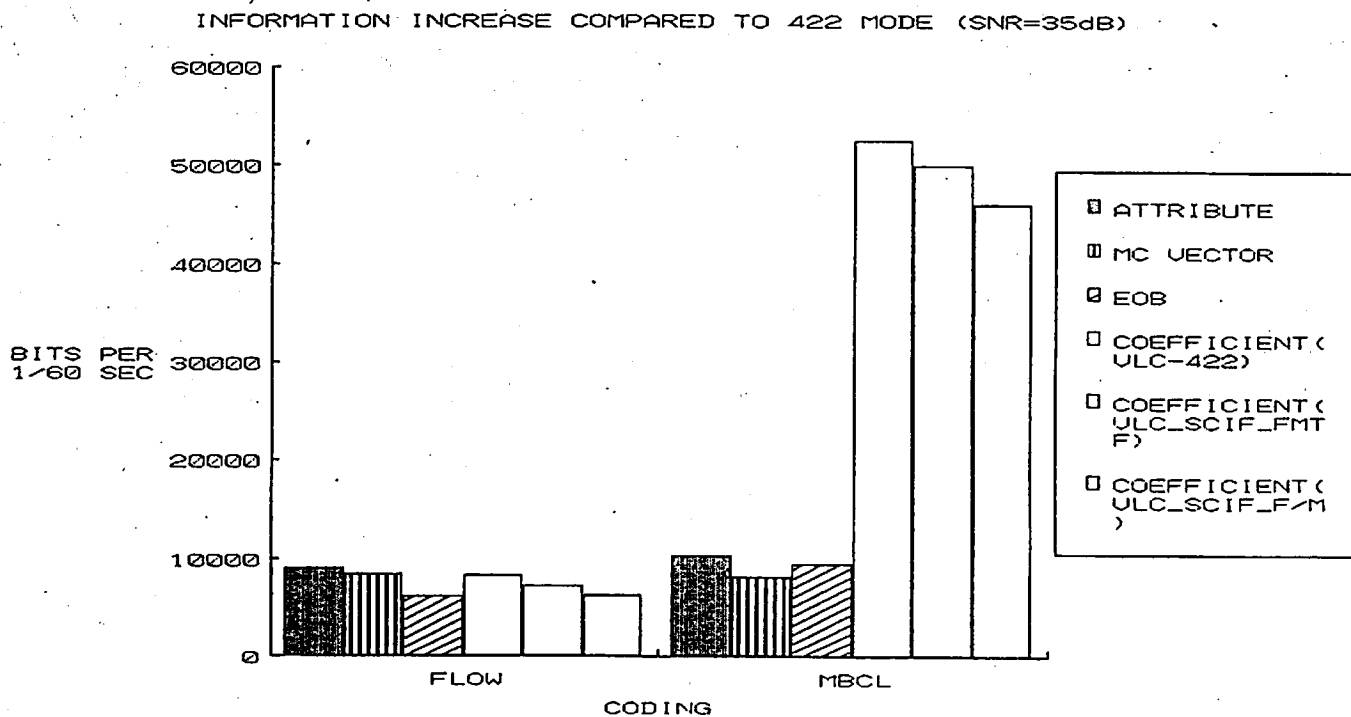


Figure 3 Number of increased bits per 1/60 sec

INTRA CODING FOR FLOWER GARDEN / MOBILE & CALENDAR

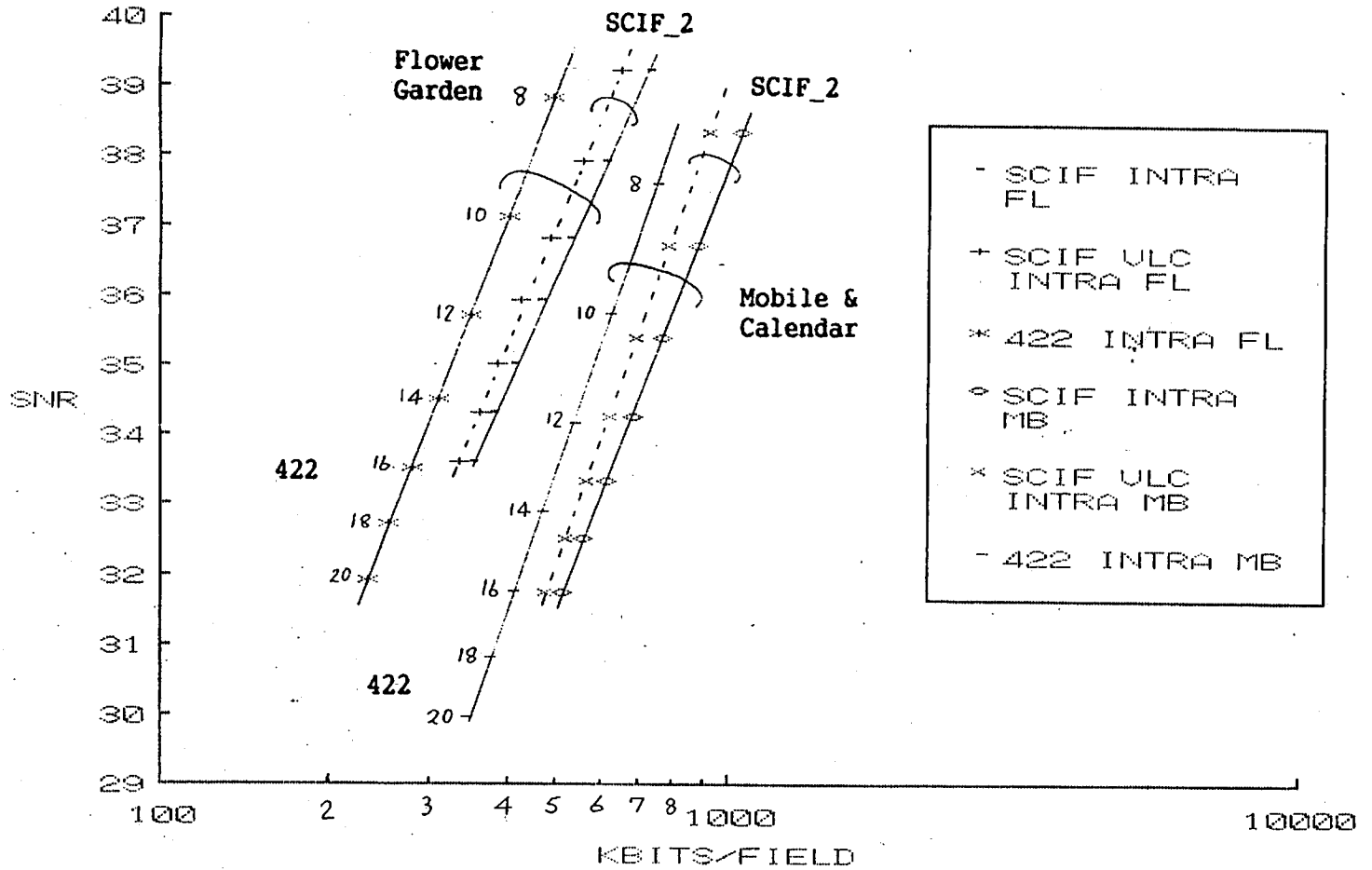


Figure 4 Coding efficiency of INTRA mode

4. Observations

- 1) The coding efficiency improves only by 1% or less at INTER mode by using SCIF optimized VLCs (comparison of vlc-422 vs vlc-scif-fmtf with 3 bit EOB). It can be said that the 2-d VLC is robust for the change of source signals to be coded.
- 2) VLC trained for a particular sequence may give a slightly larger improvement (comparison of vlc-422 vs vlc-scif-f with 3 bit EOB).
- 3) EOB code length is more influential, 3% improvement is found in comparison of vlc-422 vs vlc-scif-fmtf with 2 bit EOB at step size 20.
- 4) These suggest that microscopic adaptation of 2-d VLC, e.g. at each macroblock, may succeed as indicated in AVC-30.
- 5) In order to reduce the overhead bits in SCIF coding, a larger size of macroblock (and/or motion compensation block) may be required.
- 6) INTRA needs its optimized VLC if we consider that intra mode is frequently used in some applications and that intra only codecs are beneficial in other applications.
- 7) The 8x8 block of SCIF converted frames should have only 1/2.4 vertical bandwidth compared to that of original interlaced fields in case that 240-line pictures are converted to 576-line ones. A suitable scan order may improve the coding efficiency.

5. Conclusion

As far as a single 2-d VLC table is used in the hybrid coding, it is concluded that we can not expect to save coding efficiency loss due to the use of the progress SCIF by optimizing the 2-d VLC for INTER pictures. For INTRA pictures, however, use of an optimized 2-d VLC that is different from the one for INTER improves coding efficiency by up to 10%.

END

Annex

2D-VLC for 422 Sep 7, EOB=3bits, from 5 hisfiles

255 63

-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12
19	19	19	10	10	9	8	8	7	6	5	3	0	3	5	6	7	7	8	9	10	10	11	19	19
19	19	19	19	19	19	11	10	9	8	6	5	1	5	6	8	9	10	11	19	19	19	19	19	19
19	19	19	19	19	19	19	19	10	8	6	5	2	5	6	8	10	19	19	19	19	19	19	19	19
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19	19	19	19	19	19	19	19	19	19	19	9	18	9	19	19	19	19	19	19	19	19	19	19	19
19	19	19	19	19	19	19	19	19	19	19	9	19	9	19	19	19	19	19	19	19	19	19	19	19
19	19	19	19	19	19	19	19	19	19	10	8	20	7	10	19	19	19	19	19	19	19	19	19	19

vlc-422

2-d VLC for SCIF (EOB=3) using flow/foot/mbcl/tble ◇, 11 OCT 91

999 63

-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12
19	19	11	10	10	9	8	7	7	5	4	4	0	4	4	6	7	7	8	9	10	10	11	19	19
19	19	19	19	19	19	10	9	8	7	6	5	1	5	6	7	8	9	10	19	19	19	19	19	19
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19	19	19	19	19	19	19	19	19	19	19	11	20	11	19	19	19	19	19	19	19	19	19	19	19

vlc-scif-fmtf

2-d VLC for SCIF using flow only (12 OCT 91); EOB=3

999 63

-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12
20	20	20	11	10	10	9	8	7	6	4	4	0	4	4	6	7	8	9	10	10	11	20	20	20
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20	20	20	20	20	20	20	20	20	10	8	6	4	6	8	10	20	20	20	20	20	20	20	20	20
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vlc-scif-f

2-d VLC for intra using 7 sequences (EOB=3) 29 OCT 91

999 63

-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12
9	8	8	8	7	7	6	6	5	5	4	4	0	4	4	5	5	6	6	7	7	8	8	8	8
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19	19	19	19	19	19	19	19	19	19	19	19	17	19	19	19	19	19	19	19	19	19	19	19	19
19	19	19	19	19	19	19	19	19	19	19	19	18	19	19	19	19	19	19	19	19	19	19	19	19
19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19
19	19	19	19	19	19	19	19	19	19	19	19	20	19	19	19	19	19	19	19	19	19	19	19	19

vlc-scif-intra