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CCITT SGXV
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Specialists Group on Coding for Visual Telephony

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TITLE: Improvement of the 1st frame picture quality

Introduction

Some modifications of the coding schemes for the 1st frame are studied to improve the picture quality of the 1st frame and the following several frames.

Coding techniques

In RM5, the averages of Y,U and V of each Macro Block(MB) in the 1st frame are sent, and some AC-components are also sent when overflow is not taken place. The following techniques are studied.

1) DC-components of each MB are coded by DPCM.
For each MB, Dy,Du and Dv are calculated as (1)-(3) and coded by the variable length codes (VLC) set shown in Table 1.

$$Dy(i,j) = AVEy(i,j) - Py(i,j) \quad \text{---(1)}$$
$$Py(i,j) = AVEy(i-1,j) \quad \text{..... } i>=2$$
$$= 128 \quad \text{..... } i=1$$

$$Du(i,j) = AVEu(i,j) - Pu(i,j) \quad \text{---(2)}$$
$$Pu(i,j) = AVEu(i-1,j) \quad \text{..... } i>=2$$
$$= 128 \quad \text{..... } i=1$$

$$Dv(i,j) = AVEv(i,j) - Pv(i,j) \quad \text{---(3)}$$
$$Pv(i,j) = AVEv(i-1,j) \quad \text{..... } i>=2$$
$$= 128 \quad \text{..... } i=1$$

AVEy(i,j) means the average of Y in the MB located in (i,j). (i=1,2,...,22;horizontal, j=1,2,...,18;vertical)

The VLC set (Table 1) is generated according to the statistics of the whole frames in 4 sequences (CLAIRE, MISS-AMERICA, SALESMAN, SWING).

2) A VLC set for the 1st frame AC-components and Run-length is modified.
2-dimensional VLC set for the intraframe coded AC-components and Run-length(AC-RL) is generated according to the statistics of whole frames in the 4 sequences. The statistics are found to be different from those with normal motion compensated interframe coding. The AC-RL VLC set for the 1st frame is shown in Table 2.

3) Buffer control technique is modified in order to equalize the quantizer stepsizes through the 1st frame.
In RM5, quantizer step 'g' varies as a function of buffer

fullness. New control technique also uses the buffer fullness as shown in (4).

$$g = 2 * \mathrm{int}(pr\_buf / 200) + 2 \qquad ---(4)$$

where

$$pr\_buf = b\_init + (b\_cont - b\_init)*18/(j-1) \quad ..... \quad j >= 2$$
$$= 16 \quad ..... \quad j = 1$$

j : vertical location of group of block(GOB) under coding (j=1,2,...,18).
pr_buf : predicted buffer content after the whole 1st frame is coded.
b_init : buffer contents before 1st GOB is coded. Usually buf_init is zero.
b_cont : buffer contents after (j-1)th GOB is coded.

Simulation results

Table 3 and Fig. 1 show the simulation results.

The adoption of DPCM and AC-RL VLC improves the 1st frame SNRs by 0.3 - 5 dB and the mean sequence SNRs by 0.1 dB comparing with RM5, respectively.

The adoption of Buffer control improves the picture quality, though it does not improve SNRs so much.

By these 3 modifications, the improvement of the picture quality can be observed within the first 10 frames or so (about 1 second). After these frames, however, the difference from RM5 seems to be negligibly small.

Conclusion

Some studies on the 1st frame coding scheme will be continued, since:

1)the picture quality of the first 10 frames is considered to be very important, and
2)the physical hardware size to be added is so small.

TABLE 1 : WORD LENGTH OF VLC FOR DC DPCM (Y)

-255	-254	-253	-252	-251	-250	-249	-248	-247	-246	-245	-244	-243	-242	-241	-240	-239	-238	-237	-236
13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13

all 13

-95	-94	-93	-92	-91	-90	-89	-88	-87	-86	-85	-84	-83	-82	-81	-80	-79	-78	-77	-76
13	13	13	13	13	13	13	13	13	13	13	13	13	9	9	9	9	9	9	9

-75	-74	-73	-72	-71	-70	-69	-68	-67	-66	-65	-64	-63	-62	-61	-60	-59	-58	-57	-56
13	13	13	13	9	9	9	9	9	9	13	13	13	13	13	13	13	13	13	13

-55	-54	-53	-52	-51	-50	-49	-48	-47	-46	-45	-44	-43	-42	-41	-40	-39	-38	-37	-36
9	13	13	13	13	13	13	13	9	13	9	9	9	10	9	9	9	9	8	9

-35	-34	-33	-32	-31	-30	-29	-28	-27	-26	-25	-24	-23	-22	-21	-20	-19	-18	-17	-16
9	9	8	8	9	8	8	7	7	8	8	8	7	7	7	7	7	8	8	7

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

5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
6	6	6	7	7	7	7	7	7	7	7	8	8	8	8	8	8	8	8	8

25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44
8	8	7	7	7	7	8	8	8	8	9	9	9	9	9	9	10	10	13	9

45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64
9	9	9	9	9	9	9	13	13	13	13	13	10	13	13	13	13	13	10	13

65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84
13	13	13	13	13	13	9	9	9	13	13	10	13	9	8	10	9	8	8	9

85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
9	9	9	9	9	10	13	13	13	9	13	13	13	13	13	13	13	13	13	13

all 13

245	246	247	248	249	250	251	252	253	254	255
13	13	13	13	13	13	13	13	13	13	13

DIFFERENCE WORD LENGTH

WORD LENGTH OF VLC FOR DC DPCM (C)

-255	-254	-253	-252	-251	-250	-249	-248	-247	-246	-245	-244	-243	-242	-241	-240	-239	-238	-237	-236
14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14

all 14

-35	-34	-33	-32	-31	-30	-29	-28	-27	-26	-25	-24	-23	-22	-21	-20	-19	-18	-17	-16
14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	9	9	9

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

5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
6	7	7	7	8	8	7	7	7	7	8	9	8	14	9	14	9	14	14	9

25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44
14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14

all 14

245	246	247	248	249	250	251	252	253	254	255
14	14	14	14	14	14	14	14	14	14	14

DIFFERENCE WORD LENGTH

TABLE 2 : WORD LENGTH OF VLC FOR TWO-DIMENSIONAL CODING (RL-AC)

RUN	LEVEL (absolute value)																									
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	···· 128
0	3	5	6	6	7	8	8	8	8	9	10	10	10	11	10	10	11	12	21	21	21	21	21	21	21	···· 21
1	5	7	8	9	10	11	12	12	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	
2	6	8	9	9	10	21	12	12	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	
3	6	9	11	11	11	12	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	
4	7	10	11	11	10	11	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	
5	7	9	10	10	11	12	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	
6	8	11	12	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	
7	8	11	12	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	
8	8	11	9	10	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	
9	8	9	10	12	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	
10	9	11	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	
11	9	11	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	
12	9	11	9	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	
13	9	12	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	
14	11	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	
15	12	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	
16	11	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	
17	12	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	
18	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	
19	12	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	
20	12	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	
21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	
22	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	
23	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	
24	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	
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.																										
63																										

TABLE 3 : RESULTS OF SIMULATION

	SEQUENCE	SNR (dB)		
		RM5	DC DPCM+VLC	+ BUFFER CTRL.
The 1st frame	CLARE Y	22.31	24.93(+2.62)	29.95(+7.64)
	R-Y	32.46	34.05(+1.59)	34.81(+2.35)
	B-Y	37.90	38.67(+0.77)	37.74(-0.16)
	SALESMAN Y	22.08	22.83(+0.75)	22.83(+0.75)
	R-Y	32.94	34.93(+1.99)	34.93(+1.99)
	B-Y	32.68	35.08(+2.40)	35.08(+2.40)
	SWING Y	17.65	17.98(+0.33)	18.07(+0.42)
	R-Y	24.93	25.25(+0.32)	25.25(+0.32)
	B-Y	27.99	28.51(+0.52)	28.43(+0.44)
	MISS A. Y	29.26	34.33(+5.07)	33.70(+4.44)
	R-Y	34.24	37.14(+2.90)	37.20(+2.96)
	B-Y	30.98	35.92(+4.94)	35.59(+4.61)
Mean of whole sequence	CLARE Y	37.85	37.94(+0.09)	37.95(+0.10)
	R-Y	38.64	38.79(+0.15)	38.71(+0.07)
	B-Y	41.79	41.92(+0.13)	41.62(-0.17)
	SALESMAN Y	29.84	29.95(+0.11)	29.95(+0.11)
	R-Y	37.34	37.45(+0.11)	37.45(+0.11)
	B-Y	38.18	38.24(+0.06)	38.24(+0.06)
	SWING Y	28.65	28.83(+0.18)	28.82(+0.17)
	R-Y	31.12	31.25(+0.13)	31.28(+0.16)
	B-Y	32.58	32.75(+0.17)	32.73(+0.15)
	MISS A. Y	37.68	37.78(+0.10)	37.80(+0.12)
	R-Y	37.72	37.81(+0.09)	37.75(+0.03)
	B-Y	38.48	38.60(+0.12)	38.54(+0.06)

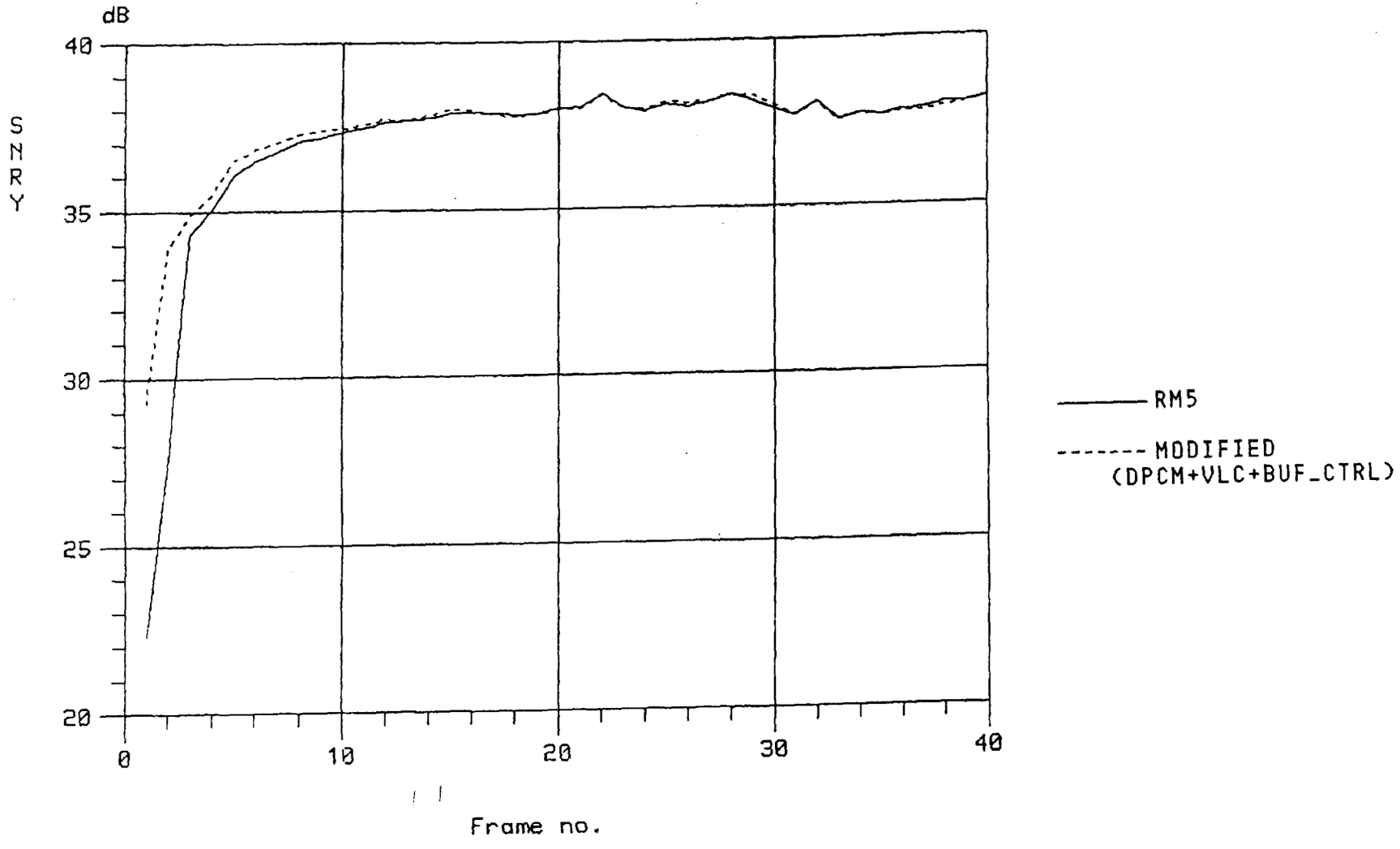

Fig. 1 Transition of SNRs (CLAIRE-Y)