CCITT SGXV
Working Party XV/1
Specialists Group on Coding for Visual Telephony

Document #460
March, 1989

LTR

SOURCE : JAPAN
TITLE : Coding results using adaptive quantizer

1. Introduction

In this document, some motion adaptive quantizers are studied and the simulation results are shown.

2. Motion adaptive quantizer

The sub-blocks can be classified into two types using motion vector. One is *MC-SB* type which is the group of sub-blocks included in the macro block with a motion vector and another is *NO MC-SB* type which is the group of sub-blocks included in the macro block without a motion vector. In Table 1, the deviations of DCT coefficients (c_i , $i = 1 \sim 64$) are shown. The significant difference in the power of DCT coefficient between *MC-SB* and *NO MC-SB* can be observed. Therefore it might be possible to improve the picture quality using the motion adaptive quantizer.

We investigated the efficiency of motion adaptive quantizer as follows :

a) In order to improve the picture quality of *MC-SB*, set the quantizer step size (g') for the *MC-SB* as follows :

$$g' = g + \Delta g$$

where g is the quantizer step size defined in RM 7 and Δg is basically set to negative value. For the *NO MC-SB*, g' is set to be equal to g.

b) In order to control the number of the coefficients to be quantized into non-zero value, quantize only the first k-coefficients in zig-zag scanning order and quantize the others into 0, if the sub-block is *MC-SB*.

This quantizer control can be realized in the flexible hardware by assigning the MC on / off information bit (1bit) to the address of selection table (Fig. 4, Annex 3 to Doc. #445R).

3. Simulation results

The results of computer simulation are shown in Table 2. The SNR for coded moving area is improved by 0.4 dB. Since the total SNR, in the case of test sequence, mainly depends on the SNR for background area, the improvement in SNR for whole frame is slight.

4. Conclusion

The SNR for coded moving area is improved by 0.4 dB using the motion adaptive quantizer. In a practical use, there is a possibility that picture quality will be improved by a combination of this adaptive quantizer and a pre-filter. Further study on quantizer control might be necessary through the implementation of flexible hardware.

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Table 1. The deviations of DCT coefficients (Sequence : Miss America)

(a) The deviations of DCT coefficients for *MC-SB*

*** Deviations (average of the 2nd ~ 50th coded frames) ***

*** Total	***						
185.782	73.171	50.654	33.529	20.830	14.233	9.058	8.233
131.046	49.278	33.983	22.592	14.498	9.265	6.285	6.459
90.246	38.428	24.971	15.447	9.449	6.631	4.320	4.623
59.718	25.458	14.278	9.053	5.991	4.078	2.527	3.036
41.095	15.831	8.885	5.378	3.364	2.491	1.371	3.827
26.798	8.708	4.706	2.602	1.803	1.596	.898	2.131
15.981	4.657	2.654	1.923	1.190	2.597	1.199	13.745
9.858	3.582	1.882	1.277	.830	1.667	.790	7.691
*** Y	***						
234.116	82.211	53.543	35.545	24.633	17.656	10.943	9.138
172.183	58.660	39.674	26.949	18.402	11.666	7.429	7.169
114.959	47.476	31.418	19.818	12.252	8.354	5.100	5.088
72.913	31.235	17.963	11.769	7.895	5.106	2.987	3.395
46.640	18.474	10.407	6.778	4.381	3.061	1.609	4.545
27.688	10.132	5.234	3.084	2.265	1.956	1.072	2.493
16.161	5.228	2.895	2.283	1.480	3.065	1.506	15.588
11.172	4.231	2.035	1.481	1.016	2.010	.983	9.014
*** Cb	***						
60.809	33.702	26.400	16.790	5.184	1.002	.341	.105
45.362	26.847	17.446	8.710	2.995	.775	.243	.094
40.031	20.852	11.357	5.323	1.929	.562	.191	.084
34.683	15.986	8.052	3.824	1.360	.384	.138	.085
29.616	13.420	7.749	2.958	1.001	.320	.111	.076
24.020	7.603	4.819	2.055	.843	.256	.105	.073
14.613	4.744	2.791	1.398	.560	.201	.092	.071
7.503	3.036	2.090	1.076	.456	.166	.085	.069
*** Cr	***						
97.923	70.570	59.489	39.031	15.084	2.898	.805	.189
44.905	31.771	25.476	16.545	6.288	1.258	.275	.102
36.896	17.790	10.661	5.540	2.292	.532	.146	.077
27.728	10.243	4.581	2.242	.947	.265	.109	.079
26.907	6.137	3.135	1.713	.627	.204	.092	.072
23.324	3.153	1.797	.971	.420	.156	.086	.069
14.890	1.626	1.086	.590	.282	.117	.079	.071
5.834	1.041	.710	.424	.238	.104	.071	.066

(b) The deviations of DCT coefficients for *NO MC-SB*

*** Deviations (average of the 2nd ~ 50th coded frames) ***

*** Total	***						
45.549	24.662	15.794	9.162	5.818	4.358	4.265	5.763
28.746	13.615	8.118	4.993	2.951	2.407	2.197	4.502
16.620	8.284	4.846	2.861	1.850	1.726	1.642	2.804
13.888	5.054	2.894	1.757	1.199	1.284	1.075	2.813
8.886	3.114	1.844	1.142	.813	.922	.634	2.392
7.039	1.768	1.176	.756	.580	.674	.428	1.607
9.533	1.322	.750	.849	.466	1.500	.540	10.001
7.481	.943	.554	.560	.332	.870	.354	5.217
*** Y	***						
48.024	23.032	14.166	7.448	5.548	4.904	4.922	6.443
29.244	13.375	7.866	4.767	3.416	2.929	2.487	5.092
15.011	7.667	4.586	3.053	2.229	2.097	1.864	3.149
11.578	4.289	2.604	1.810	1.422	1.551	1.239	3.462
7.192	2.306	1.411	1.090	.940	1.115	.742	3.100
4.635	1.153	.765	.666	.658	.829	.518	2.138
8.042	1.016	.452	.947	.539	1.969	.700	13.635
5.609	.688	.325	.590	.374	1.133	.454	7.139
*** Cb	***						
35.856	18.597	13.148	8.925	2.755	.676	.222	.148
23.803	11.394	6.800	4.104	1.535	.417	.129	.066
19.443	8.208	5.026	2.556	1.074	.309	.103	.064
17.629	6.106	3.724	1.999	.838	.249	.089	.058
10.290	4.574	2.913	1.550	.670	.206	.077	.057
11.682	3.138	2.196	1.195	.523	.159	.071	.053
16.920	2.261	1.514	.855	.388	.133	.064	.053
12.114	1.670	1.145	.661	.304	.114	.061	.051
*** Cr	***						
43.724	35.273	23.552	15.713	9.107	1.900	.590	.213
27.789	14.694	9.230	6.482	2.317	.510	.137	.069
15.928	8.532	4.522	2.129	.872	.254	.086	.060
15.190	4.791	2.082	1.045	.454	.142	.072	.060
10.870	2.831	1.437	.668	.314	.121	.065	.056
8.506	1.279	.870	.461	.224	.098	.061	.055
5.402	.797	.546	.338	.170	.084	.059	.054
8.475	.561	.398	.256	.146	.075	.055	.054

Table 2. Results of computer simulation

Sequence : MISS AMERICA
bit rate : 59.4(kbit/sec) frame rate : 10.0(Hz)

*** Frame no. *** : 2 ~ 50

		rm7	k= 15	k= 28	k= 36	Δg=-6	Δg=-4	Δg=-2	k= 28 Δg=-6	k= 28 Δg=-4	k= 28 Δg=-2
1. RMS for luminance		3.23	3.28	3.22	3.22	3.25	3.24	3.23	3.24	3.23	3.22
2. SNR for luminance		37.95	37.81	37.98	37.96	37.89	37.93	37.95	37.90	37.93	37.96
	(FIXED)	(41.00)	(40.90)	(41.04)	(41.05)	(40.39)	(40.61)	(40.80)	(40.44)	(40.64)	(40.85)
	(CODED MC)	(34.51)	(34.12)	(34.53)	(34.55)	(34.90)	(34.83)	(34.72)	(34.93)	(34.84)	(34.76)
	(FIXED MC)	(36.68)	(36.48)	(36.75)	(36.76)	(36.66)	(36.75)	(36.73)	(36.74)	(36.74)	(36.84)
	(CODED)	(37.54)	(36.77)	(37.60)	(37.55)	(36.91)	(37.10)	(37.32)	(36.88)	(37.15)	(37.33)
	(INTRA)	(34.08)	(-----)	(33.99)	(33.66)	(33.99)	(33.92)	(33.93)	(33.52)	(34.92)	(33.99)
SNR for chrominance Cb		37.89	37.73	37.92	37.88	37.81	37.80	37.85	37.79	37.83	37.90
SNR for chrominance Cr		38.83	38.34	38.81	38.80	38.58	38.65	38.72	38.57	38.67	38.79
3. Mean value of Step size		19.14	18.31	18.86	19.12	22.45	21.02	19.96	21.96	20.85	19.66
4. Mean value of the number of Non-zero coefficients	Y	2.42	2.25	2.39	2.41	2.91	2.69	2.56	2.77	2.65	2.48
	C	1.40	1.48	1.39	1.39	1.59	1.49	1.44	1.57	1.47	1.42
5. Mean value of the number of zeros before the last NZ-coef.	Y	3.95	3.46	3.75	3.92	4.66	4.37	4.17	4.12	4.02	3.88
	C	2.56	3.15	2.55	2.45	2.66	2.50	2.52	2.69	2.57	2.52
6. Block type of MACRO	FIXED	215.4	222.8	214.4	214.2	242.7	232.5	223.9	240.2	231.1	224.1
	CODED MC	72.6	57.4	73.4	73.6	78.4	77.6	75.8	79.8	78.1	77.0
	FIXED MC	24.4	12.1	23.4	23.8	20.6	21.2	22.2	19.3	20.2	20.8
	CODED	83.5	103.7	84.8	84.3	54.2	64.6	74.1	56.6	66.5	74.0
	INTRA	0.1	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.0	0.0
7. Block type of Y	FIXED	1120.4	1205.9	1121.0	1118.7	1143.2	1134.9	1127.8	1140.8	1135.7	1127.2
	CODED MC	129.2	111.1	129.6	128.7	143.6	141.6	135.6	146.1	143.2	138.9
	FIXED MC	258.8	166.9	257.4	261.0	252.4	253.7	256.3	250.3	250.2	252.3
	CODED	75.6	100.1	76.0	75.6	44.8	53.9	64.3	46.8	54.9	65.6
8. Block type of C	FIXED	686.5	679.4	684.4	686.9	701.5	695.2	691.0	698.0	693.0	688.2
	CODED	105.5	112.6	107.6	105.1	90.5	96.8	101.0	94.0	99.0	103.8
9. Number of bits	Macro attributes	1209.0	1251.5	1222.0	1217.6	1017.2	1090.9	1151.7	1036.1	1103.3	1156.4
	End of block	977.7	1021.7	990.4	978.9	855.2	906.3	945.3	882.4	922.4	961.1
	Motion vectors	608.5	408.4	604.2	618.8	627.5	629.4	615.0	632.4	621.2	613.3
	DC coeffcients	0.5	0.0	0.3	0.5	0.3	0.3	0.3	0.5	0.3	0.3
	Coefficients Y	2440.9	2317.4	2410.6	2432.0	2739.0	2623.1	2542.3	2667.0	2591.0	2508.7
	Coefficients Cb	328.1	379.7	323.7	322.8	317.3	309.4	314.8	326.1	320.2	320.0
	Coefficients Cr	341.2	444.5	353.4	335.8	350.8	347.0	340.4	363.2	348.7	350.3
	Coefficients Total	3110.2	3141.6	3087.7	3090.7	3407.1	3279.4	3197.4	3356.3	3259.9	3179.0
	Total	5906.0	5823.2	5904.6	5906.5	5907.3	5906.4	5909.8	5907.8	5907.1	5910.1